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How plants are trained to work for man. V.4 - Small fruits.

THE FRUIT OF THE BURBANK PLUM

The famous "Burbank" plum was grown by Mr. Burbank on a tree introduced from Japan. It is now grown in enormous quantities, under the most diversified conditions of soil and climate all over the world.

HOW PLANTS ARE TRAINED
TO WORK FOR MAN

BY LUTHER BURBANK Sc. D

SMALL FRUITS

VOLUME IV

EIGHT VOLUMES · ILLUSTRATED
PREFATORY NOTE BY DAVID STARR JORDAN

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Material from the Orient

CLEARLY to apprehend the conditions of the problem that confronted me when I first undertook on a comprehensive scale to put my ideas as to plant development into execution, it is desirable to note very briefly the characteristics of the different races of plums that were brought to the Santa Rosa melting pot. Let me outline them.

Reference has already been made more than once to the Japanese seedlings. The plums from this source, like those from every other, typify in many respects the people among whom they were developed. Modified to meet the needs of an island people occupying a relatively small territory which nevertheless compasses many degrees of latitude, the Japanese plums differ a good deal among themselves as to their hardiness. But in general they are rapid growers, with early and abundant bearing qualities, and unusual adapta-

bility to wide ranges of climate. The fruit is unique in form. It averages large in size, with a high percentage of flesh to stone, and with both skin and flesh of high color.

The brilliant purple, crimson, pink, and yellow shades shown by some of the modern hybrids are a tribute to the Japanese members of their ancestral stock.

But while the Japanese plums have these signal merits they are not without their faults. Many of them are small and most of them lack flavor, and freestone qualities had not been developed in the slightest degree. Many of them lack timeliness of bearing; others bloom so early that the crop is often destroyed by late spring frosts or heavy rains.

Moreover the Japanese often eat plums that are hard and green, preserving them by pickling; therefore they have sometimes neglected to appreciate the sweetness and flavor of the fruit.

These, obviously, are defects that the plant improver must bear constantly in mind when he sets out to separate and recombine the traits of his company of plums.

The Chinese, near neighbors of the Japanese, developed plums of a different type. The Japanese plum is known as *Prunus triflora;* it perhaps originated or was developed in Korea, south-

ern Siberia, and northern China. But the Chinese apricot-plum, known to the botanist as *Prunus Simonii,* must have originated in some semitropical climate. It has form and color suggestive of a tomato. It perhaps originated near the native home of the apricot, to which fruit it appears to be somewhat more closely related than to other plums.

The fruits of China, apparently, have not been greatly modified for many centuries. They therefore tend to fixity. Indeed, they furnish a typical example of the way in which the conservatism of a race may be stamped upon its fruit. Or is it that people and plants alike are conservative because of the climatic conditions that environ them?

In any event, the Chinese plum, when combined with other species of plums, brings to the union characteristics that are highly important.

Thus the Chinese plum has a delightful aroma, it is of unique form and rich color, and the stone is very small in proportion to the flesh.

On the other hand this plum is chiefly adapted to arid, semitropical climates; the fruit is likely to remain bitter, and it may crack so badly as to be utterly worthless.

Fortunately the merits may be retained, and the faults eliminated, in the hybrid progeny.

Materials from Europe and America

The more common European plum manifests no less markedly than the Oriental one the tastes of the people by whom it has been developed.

European fruit growers have had in mind many and diverse qualities of fruit, and they have developed diversified races of plums. The original species from which the best of these have grown is known as *Prunus domestica.*

Doubtless at a time sufficiently remote this plum was of the same ancestral stock with the Japanese and Chinese species. But many centuries of modification to meet the tastes of the Caucasian races have so altered it that it would be difficult to say what were its original characteristics.

The Western races, carrying the plum with them to different regions, developed widely different tastes and inclinations, and the plums that were ultimately grown to meet the tastes are of course equally diversified in quality. Some are large and some small; some exquisitely sweet, others relatively sour. Some are adapted to eating while fresh; others are most useful for drying or for canning.

In a word, the races to which the western plum has catered are of complex lineage; they live in

widely varying climates and under greatly diversified conditions.

The Caucasian lives everywhere and his fruits have adapted themselves to his condition.

Summarized in a few words, the advantages of the European plums are: wide diversity as to colors, qualities, and flavors, and adaptability to a wide range of climate.

The faults of the European plums are these: the stone is quite generally too large for the size of the fruit; the fruit itself in most cases is too juicy—sometimes absolutely watery—and there is a wide range of textures to be avoided, including stringiness, brittleness, and sponginess. Moreover, large size and exquisite quality are seldom combined. The green gage, the standard of excellence among the hardier European plums, is quite small, and the tree is unproductive. And the large European plums are quite often lacking in texture and flavor.

Size and quality are not correlatives in the case of these plums.

It must be especially noted, however, that it is the European plum, in some of its varieties, that has the qualities of large sugar production that permits it to dry readily in the sun without fermentation. This variety of plum, known as the prune, has been the means of building up a

great world industry. At the moment, however, we are chiefly concerned with the plums in general rather than with this particular race.

There remain the American plums—that is to say the plums that were found growing in America at the time of European discovery.

There are several quite distinct species of these indigenous plums. They grow far to the north, and perhaps their most important characteristic is their hardiness. Some of them resist the scorching heat of tropical America; others thrive and bear in the short seasons of the snowy north. With hardiness of tree has been developed a strain of productiveness. Various wild plums often cover the ground in the fall with layers of ripened fruit.

Notwithstanding this, however, the crop is uncertain, some of the thriftiest trees proving unproductive in certain seasons, and the fruit is always inferior in size.

Many of the American plums are of fine quality, even in the wild state. Yet their faults are almost as numerous as their virtues. The trees are generally small, not usually large enough to make good commercial orchard trees. In form, too, the trees are defective. And the fruit, notwithstanding its excellent flavor, is

often soft and watery, quite lacking shipping quality.

In the Melting Pot

Obviously, then, the plums of each country offer certain good qualities and present certain defects.

To take the characteristics from the plums of each country and combine them in different varieties; to eliminate the faults as far as possible; to select and test the best among the millions of seedlings produced from the various combinations; to redistribute these fruits when produced and thoroughly tested, sending them back greatly improved, their good qualities retained and others added—this has been the work of the last forty years in the attempt to produce an ideal plum.

Having for working material plums in which different combinations of qualities have been developed for the most part unconsciously from different races, our task was a consciously scientific selection.

We must strive to produce, in a few decades, changes comparable to those that had been wrought in the course of centuries through unconscious selection by many peoples under widely diversified climates and conditions. Conscious systematic selection was to amalgamate

THE LATE SHIPPER

This is a cross between the Chinese apricot plum and a Japanese plum. The Chinese parentage is shown in the short, thick, applelike stem, clinging to the fruit, and yellowish flesh. The influence of the Japanese parent is shown in the form of the fruit and in the stone, which inclines very strongly to the Japanese type. (Natural size.)

all the best qualities of plums and plumlike fruits; those that bore the imprint of the conservatism of the Chinese race, the insularity of the Japanese, the diversity of the European, the nomadism of the Persian, the hardiness and variability of the American.

The best was to be taken from each, and the good qualities developed in five widely varying geographical territories were to be assembled, combined, sifted, and selected to produce fruit having the stability, novelty, variety, piquancy, hardiness, beauty and shipping qualities, and adaptability to new conditions and uses of the races that had left their imprint in varying measure on the ancestral stocks.

Viewing the work in retrospect, I assuredly can have no cause to regret that it was undertaken, yet it has been a most laborious task.

Doubtless the time expended on the plum has been at least as great as that devoted to any other single line of my investigations. The labor, especially in grafting, budding, testing, and selecting, has probably been greater than that devoted to any other plant origination, with the possible exception of the spineless cactus.

Roughly speaking, I might perhaps say that the plum experiments represent, first and last,

something about one-tenth of the total expenditure for my experimental work.

In importance, up to the present time, judged by results, the work with the plum may represent perhaps one-sixth of all my work; in extent and variety, perhaps one-tenth of the total. In commercial value, up to the present, perhaps the plums may be credited with one-third; but they will rank by no means so high when the final ledger is balanced, for there are very numerous other productions, among them the cactus, that loom large in prospective value.

So in the end perhaps the economic rank of the plums, among the total of my plant productions, will not be more than one-twentieth.

Yet when I state that from among the almost countless new varieties that have been developed through these forty years of experiment, sixty-seven have so far been thought worthy of introduction, and some thousands of races are still undergoing tests, some inkling of the work involved will be gained. And when I add that the Burbank plums now make up about one-third of the total export of the plums from California year by year, and that my protégés are as popular in South America, Europe, Asia, Africa, Australia, and New Zealand, and in

numerous other remote regions of the globe, as they are in the State where they originated, something of the economic importance of the experiments in plum development will be revealed.

Specific Results

Some glimpses have been given in earlier chapters of the methods of experimentation through which particular races of new plums have been developed; and fuller details of the methods and results will be given in subsequent chapters of the present volume. Here let me briefly outline some of the earlier results of my effort at hybridizing the diversified races that were brought together for the purpose of these comprehensive experiments.

I have said that some notable results were obtained almost from the outset.

As illustrating this, it may be recalled that, whereas the first hybridizations between the Japanese seedlings and plums of European and American stock were made in 1888, there were no fewer than six varieties of hybrids in my orchard in the season of 1893, only five years later, that were considered worthy of introduction and that were able to take rank at once as superior in some regards to any plums at that time known.

Two of these, named respectively the Delaware and the Hale, were hybrids of a double oriental stock, one parent being the Kelsey, a Japanese plum introduced by the orchardist whose name it bears, and the other my Japanese Satsuma.

A third was a hybrid between a Japanese plum named the Sweet Botan, or Golden, and the Robinson, an American plum of the Chickasaw race.

Two others were crosses of the Robinson and Abundance.

The sixth was a cross between the Kelsey and the Burbank, its ancestral strains being therefore Japanese. This plum was first named Perfection, but it was afterward renamed the Wickson, in honor of Professor Edward J. Wickson of the University of California.

All these are exceptional plums, but the Wickson was preeminent in virtue of its combination of good qualities. The tree grows upright, largely in vase form. It branches gracefully, and it is productive almost to a fault. The fruit is large and handsome. From the time when it is half grown to a few days before ripening it is pearly white in color, but all at once numerous pink dots appear, and in a few days it has turned to green flushed with crimson with a

heavy white bloom. The stone is small and the flesh of fine texture, firm, sugary, and delicious. It will keep two weeks or more after ripening; or it can be picked when hard and white, and will color and ripen almost as well as if left on the tree.

The general excellence of this fruit may perhaps best be gauged by the statement that last year more than one hundred carloads of this variety alone were shipped from California to the eastern markets.

Difficulties Overcome

But while these notable successes attended the earliest hybridizing efforts, it must not be supposed that the experiment was carried out without difficulty.

In fact it was not easy to effect the cross between the Japanese plums and the European varieties. Some varieties refused to combine; and probably not more than one in a hundred of these crosses proved in any way satisfactory.

When a hybrid is produced, the traits of the Japanese plum usually seem prepotent in most of its characters, though in many cases the balance between the two is good.

Whereas the hybrids of the first generation sometimes produce fairly good fruits, as a rule

their fruit is rather soft and acid. The full possibilities are revealed only in later generations, and in particular after other species and varieties of plums have been brought into the combination.

As rapidly as possible the hybridizations were extended, until forty-three races of plums had been used. In successive generations the various strains were intermingled until they were complex far beyond computation or accurate recording.

The original seedlings were used as stocks for grafting the cions of new seedlings year by year. To this day they stand in the original rows, although little is left of the original trees except the trunk and the bases of the branches. Each season, the grafts that have been proved to be of no value are removed and cions from new seedlings are put in their place.

Most of the trees have borne from ten to twenty sets of grafts.

Details given in other chapters will enable the reader to follow in imagination the process of blending and selection through which, on the average, year by year a better and better combination of qualities was effected among my plum protégés.

Almost as a matter of course, there ultimately appeared individuals that far surpassed most of

the earlier hybrids in one or many desired qualities.

The Quartet of "Best" Plums

And in the course of years there were found at least three new varieties, all of the most complex ancestry, that excelled any of their forerunners.

The three new claimants, which stand as the finest products of plum development up to date, have been named the Santa Rosa, the Formosa, and Beauty.

These with the Wickson may be listed as unqualifiedly the best products of the experiments in plum hybridization up to date—a quartet of plums of matchless quality.

It must be understood, however, that there are unfulfilled possibilities of future development among the newer hybrids. Selection has gone on year after year until the plums that remain are all of almost infinitely complex ancestry and of fine individual quality. New crossings between the almost numberless varieties, or even new seedlings without further crossing, may result any year in producing a better plum than any hitherto produced. Indeed, this is to be expected, for in a sense the work is only begun.

Even by hastening the time of fruiting through grafting seedlings on small branches in

the way already detailed, it is impossible to test any given seedling as to its fruit possibilities in less than two or three years. So there are only twelve to fifteen generations at most between my first hybrids and the seedlings of the present year.

It is not to be supposed that all the possibilities of the multiple ancestry will be realized in any given individual within that comparatively short number of generations.

So, notwithstanding the notable results of the experiments up to the present, I have every expectation that the real greatness of my plum colony is yet to be revealed.

Meantime it is gratifying to record that unprejudiced witnesses in many parts of the world have declared the members of the quartet just named to be each in its way without a rival. Each of the four has certain points of excellence, to meet the requirements of a different market. But, as a group, the four stand in a class by themselves.

And in token that this is not a matter of accident, let me recall that in the production of these four plums selection has been made, in the course of successive generations, from not fewer than seven and a half million seedlings. Perhaps this bald statement will serve, in connection with

what is elsewhere told of methods, to give a fairly vivid impression of the work involved in the attempt to develop a perfect series of plums for all purposes.

We must strive to produce, in a few decades, changes comparable to those that had been wrought in the course of centuries through unconscious selection by many peoples under widely diversified climates and conditions.

THE GREATEST PLUM OF ALL—THE PRUNE

Forty Years in Search of a Perfect Prune

IT not unfrequently happens that a visitor from the East or some foreign land expresses a particular desire to see a fresh prune. And when the fruit is shown the visitor usually expresses surprise at its appearance.

"Why, that looks just like a big plum."

"Taste it," I said.

"It tastes exactly like a plum, too."

"There is every reason why it should," I answered; "for it is a plum. Not only so, but you may have eaten any number of prunes in New York or Bombay, as the case might be, even though you supposed that you had never seen a fresh one. The prune is an excellent table fruit and my best varieties are very good shippers.

"So a fair proportion of the best plums that are sold in the eastern market are really prunes. Yet, of course, they are called plums when sold

to be eaten fresh. And this is proper enough, for every prune is a plum, even though every plum is not a prune by any manner of means."

It is rather curious that this elementary bit of botanical information should not be more widely known. But my experience tells me that comparatively few persons living away from a prune-growing district realize that the fruit with which they are so familiar in the dry state was neither more nor less than a plum before it was dried.

In fact a prune might be spoken of as an educated plum—and educated in a particular way.

In a sense all plums of the present day are educated. Each one has been brought, by selection, in the course of centuries to a point where it is a highly edible fruit. My famous quartet of developed plums, named in the preceding chapter, are assuredly educated in a high degree. Each of them is large in size, attractive in color, delicious in flavor, and of such firm quality of flesh as to bear shipping to distant markets.

Yet no one of them has the particular kind of education that is absolutely essential for a prune.

Neither Wickson nor Santa Rosa nor Formosa nor Beauty plums would have the slightest value as additions to the orchard of the prune grower. The smallest and the poorest prune in the orchard would be preferred.

Yet the qualities that these educated plums lack are very few. Or, stated otherwise, the points of education that the prune has acquired, over and above other plums, are few. But they are absolutely essential.

The qualities in question are simply these: A capacity to produce a large percentage of sugar and store it in the juices of the fruit; and, secondly, a capacity to produce a skin covering having a peculiar quality of cracking in just the right way when the fruit is plunged into an alkali bath. Granted these qualities, any plum is a prune, lacking them, no plum is a prune of value.

As to the varying degrees in which the qualities may be attained by different races of prunes, we shall have more to say in a moment.

Going Back to the Blanket

In order to get a clear view of the matter, it will be well for us to make inquiry as to just how the prune came to take on the particular kind of education that now gives it distinction. By so doing we shall perhaps be enabled to understand better why it is that the prune finds it so easy to lapse back from the standards its forbears have established.

If I had been engaged in a forty-year-long quest of a perfect prune, without quite attaining

PRUNE D'AGEN FRUIT

This is the common French prune, originally brought to California more than fifty years ago, and grown almost exclusively until the appearance of the new Burbank prunes. It is a small, sweet fruit with a tough skin, growing on a weak tree of comparatively poor bearing qualities. Millions of pounds of this prune are now grown and great capital is invested in its production, curing, marketing, etc. (Natural size.)

the ideal, it is chiefly because this fruit shows such a propensity to forget what it has learned and to revert to the standards of the ordinary plum.

And the reason, stated in a word, is that the traits that now specifically characterize the prune have been acquired in comparatively recent generations; whereas the main characteristics that make the ordinary plum an edible fruit have been traditional in the family for untold centuries.

When I find our almost perfect prune lapsing back in the next generation to a condition that robs it of all value as a prune, I am reminded of the story of a young Indian who was taken from his tribe and given every advantage that the Government could furnish him.

Years were spent in teaching him the studies of the modern curriculum, mathematics, history, literature, language, and even a smattering of art.

At twenty-one he had a better education than many of our presidents, and his future was considered very promising by those who had to do with his training.

Ten years later this educated Indian was one of the most worthless of his tribe.

He had simply "gone back to the blanket stage of existence." The pull of past heredities was too

strong for him. The transitory influence of a few years of education could not efface the racial instincts that had been implanted through thousands of generations of breeding of a more primitive sort.

And so it is with the prunes. Through extreme specialization in recent times they have developed certain properties that were not of value to their ancestors, and, like the Indian, they are very ready to throw these off and revert to their blanket stage of existence.

So when we combine a prune with some fine variety of plum, or even cross two varieties of prunes, in the hope of getting a larger and more productive prune, we very commonly secure a fine fruit—a fruit sometimes that is in many ways superior to either parent—but a fruit that is not a prune at all in the technical sense; a fruit, in short, lacking the refinements of large sugar content and peculiar quality of covering; being, therefore, a mere plum—in a word, a blanket Indian.

And all this tends to show that we are right in assuming that the peculiar property of depositing a large quantity of sugar in the fruit is one that was not inherent with the ancestors of the prune until man undertook the education of the fruit and trained it for that particular purpose.

Remote Sugar-Producing Ancestors

Nevertheless all that we know of heredity suggests that the effort on the part of man to develop such a trait as this would not have been successful had it not chanced that there were among the ancestors of the prune some races that possessed a *tendency toward* the peculiar property of producing very sweet fruit. There is nothing anomalous in that supposition, however, for it is well known that many tropical fruits tend to have a high sugar content.

Such is the case, for example, with the date, the fig, and the pineapple.

The orange, also, in some of its varieties, is a very sweet fruit, and there are numerous others among the fruits still confined to the tropics that show the same quality.

Indeed, in general it may be said that fruits growing in the tropics tend to have a high sugar content, the reason being, perhaps, that in hot climates this is necessary to insure preservation of the fruit long enough to permit it to serve its purpose in protecting the seed during its growth and preparation for germination.

But as fruits migrate to temperate zones, they tend to give up this habit of sugar production. All pulpy fruits, to be sure, develop a certain

THE SUGAR PRUNE

The Sugar prune is a nearly perfect fruit, surpassing the Splendor in almost every respect, including vigor of tree and productiveness. Both are extremely large, freestone, of extra fine quality and have a larger proportion of flesh to stone than other prunes. The Sugar prune is now grown extensively in South America, Australia, New Zealand, and many other countries besides California. It is a stupendous bearer. (Natural size.)

amount of sugar, but the percentage is relatively small with most fruits of temperate climates. The contrast in this regard between the average wild plum and such a fruit as the fig or the date is very striking.

But we have seen illustrated over and over that a habit once ingrained in a race is with very great difficulty shaken off altogether, so it is not strange that, under exceptional circumstances or conditions of soil and climate, an individual plum tree might show reversion to the state of some ancestor and produce a fruit much sweeter than other plums.

Such an individual, if its fruit came to the attention of the orchardist, would be likely to be preserved and propagated; and in the course of time, through selection among the seedlings of this tree, a race of sweet plums would be developed.

But is is only under conditions of artificial cultivation, in all probability, that such a race could be preserved.

For, of course, the production of a large amount of sugar must draw on the energies of the tree, and if this increased sweetness of fruit did not prove beneficial to the tree itself, natural selection would presently weed it out.

So, we may fairly assume that it is only within the comparatively recent period since the plum was under cultivation that the development of a race of sweet plums, which we now term prunes, has taken place.

Just the Right Skin Texture

As to the other characteristic prune trait, that of developing a skin of such texture that it will crack in precisely the right way when put into the alkali bath, this may fairly be assumed to be an even more recent acquisition.

Yet here, again, we may assume that there were ancestors of the plum that developed characteristics of skin of which this is perhaps a reminiscence. And it is not very difficult to conceive how this may have come about.

The wild plum quite commonly grows along watercourses and by lakesides. It may chance that plums growing along the shores of the Mediterranean, or perhaps by some inland body of salt water like the Dead Sea, were covered on occasion with salt spray from dashing waves or saturated with the brine when they fell to the earth.

In such case, varieties that chanced to endure this treatment best would be the ones preserved, and in due course a race of plums having

the right texture of skin to stand this treatment would be developed.

This particular quality of skin would doubtless be subordinated when the plant migrated to regions away from the salt water and crossed with other races. But here as before the latent trait would be preserved as a submerged hereditary factor, ready when the occasion arose to make itself again manifest.

But how, it may not unnaturally be inquired, would man himself discover the value of the alkali bath in preserving the prune?

Granted that a prune had been evolved through artificial selection that had a sufficiently high sugar content to make it a drying prune, how chanced anyone to hit upon the particular method of drying that is now employed, an essential preliminary of which is the submersion of the fruit in the alkali bath?

The question is doubly pertinent because even to this day in France the use of this method is by no means universal. In many cases the prune is still dried with the aid of artificial heat, the fumes and smoke of wood or charcoal taking the place of the alkali bath in giving the right quality to the skin and aiding in preservation. So we may assume that the simpler method of using an alkali bath is of very recent origin.

THE SPLENDOR PRUNE

The fruits of the Splendor prune are so placed on the tree that it will bear an immense load without breaking. The heavy fruits are borne on the strong wood, near together, but far enough apart to obtain a good distribution of weight. Not so extensively grown as others on account of its habit of clinging to the tree instead of falling when ripe. The fruit is of exquisite quality.

Not unlikely the discovery was made altogether by accident.

Many of us can recall that in our boyhood days it was customary in New England to make lye for use in the manufacture of soft soap by percolating water through barrels filled with wood ashes. The lye thus made is closely similar in composition to the fluid that is now used in preparing the prune. It seems a reasonable conjecture that the discovery of its value in this connection may have resulted from observation that plums which chanced to drop into a bucket of lye, when removed and thrown aside were more resistant to decay and dried sooner than other plums.

Such a chance observation would have sufficed to give the clue to some ingenious person, and the value of lye as an aid in making the plum into a dried fruit would thus come to be understood.

But whether or not this was the manner of discovery, the fact remains that the lye bath is an essential part of the process of curing the prune. Therefore the quality of skin that adapts the fruit to respond properly to this treatment is one of the absolute essentials that the fruit developer must have constantly in mind.

How Sugar and Lye Cooperate

It may seem rather curious at first glance that a high sugar content should be essential to the preservation of the prune, when we reflect that sugar is a very fermentable substance. Everyone knows, for example, that starch is transformed into a form of sugar before it is fermented in the manufacture of alcohol. How, then, does the sugar in the prune prevent the fermentation of the fruit and insure its preservation?

The answer is that sugar ferments only under influence of certain living microorganisms, and that these microorganisms cannot work in a too concentrated solution of sugar. There are myriads of the microbes spread broadcast everywhere on the wind, and of course they find lodgment on the skin of the prune as on every other exposed surface.

But the alkali bath to which the prune is subjected, destroys these germs at the same time that it cracks the skin of the fruit.

Other germs would find lodgment, however, and set up fermentation, were it not that the cracked skin permits a very rapid evaporation of the water content of the fruit. This quickly brings the sugar content to a degree of concentration that makes it a powerful antiseptic—that

is to say a germicide that destroys any micro-organisms that enter it.

But unless the prune has at least 15 per cent of sugar in its pulp, it will take too long to desiccate it sufficiently to give the sugar the right degree of concentration. And unless the conditions are very exceptional, even when the plum has a sugar content of more than 20 per cent, it still will not dry rapidly enough to escape fermentation unless its skin cracks in just the right way.

A difference of the hundredth of an inch in the average interval between the cracks may make all the difference between a satisfactory prune and a nearly useless one.

Of course in the pure dry air of many regions of California, under a cloudless sky, a very sweet prune will often dry perfectly without the aid of the alkali bath; but it would not do for the prune raiser to depend upon these conditions as a general thing. He must control his prune, for he cannot control the weather.

Difficulties in Schooling the Prune

It is obvious, then, that the plant developer must always bear in mind the two particular features of the fruit's education he has to contend with.

PRUNE DRYING IN CALIFORNIA

This is a typical scene in the California prune district. In the foreground are seen piles of trays not at present in use. In the background the trays, covered with prunes, are laid out on the ground while the fruit dries in the sun. Before drying, the fruit is sterilized and the skin properly cracked by dipping in a lye bath. These prune-drying establishments quite often occupy many acres each.

But it is also understood that there are many other features that cannot be ignored.

A prune tree, like any other plum tree, must be a good grower and a full annual yielder. The fruit must ripen early in the season while the days are long and warm. It must drop from the tree in exactly the right stage of ripeness that the orchardist may not be put to the trouble and expense of picking it. The fruit should have a small stone and if possible a free stone—overlooking for the moment the question of entire stonelessness which will doubtless be required of the prune of the future.

Again, the trade demands a glossy black prune, for—owing, perhaps, to the fact that the French prunes, especially those cured in the smoke, are black—the average purchaser is prejudiced against the prune of lighter color even though it be of better quality.

When we consider how many of these traits are different from those required in the ordinary plum, and hence have been developed in recent times under conditions of artificial selection, it will be obvious how largely the task of the prune developer must be carried out in opposition to the main stream of heredity; and it will not seem strange that forty years has proved none too long a time in which to develop the perfect prune.

If I were to attempt to make a guess—it, of course, would be only that—as to the number of generations that have elapsed in the history of the prune since the qualities that chiefly characterize it were developed, my estimate would be something like this:

The tendency of the fruit to drop promptly at the right time has been in vogue for perhaps only five or ten generations out of the thousands of generations since plums were brought under cultivation.

The quality of producing sufficient sugar in the right form for drying may have been developed during perhaps the last twenty-five generations; but it has been brought to its present high precentage during the most recent half dozen generations.

The condition of the skin which allows it to crack in just the right way has without doubt been cultivated for only a few generations.

But on the other hand the fairly edible flesh, not having a high sugar content, has been the heritage of the plum for thousands of generations.

So we can readily understand that the plant developer may secure among many thousands of seedlings, nearly all of them producing plums of fair quality, perhaps only one that may show the

qualities that specifically characterize the prune even in a minimum degree.

The progenitors of the seedlings may have been prunes of fair quality; but the seedlings themselves have gone back to the blanket stage of plum development.

The chances against securing even a single fruit that combines all the desired qualities among any given lot of seedlings are so small as to be almost disheartening.

Indeed when the plant developer brings together two strains, each carrying its galaxies of more or less antagonistic characters, it is not altogether unlike scattering the letters of the alphabet in a whirlwind and expecting them to fall together in some chance eddy in such a way as to spell out some specified word.

Marking Progress

I was not unmindful of the difficulties of the project, but nevertheless the obvious need of a better prune than California growers had been able to secure by importation appealed to me from the time of my first coming to the State; and when I undertook plant experimentation on a large scale, the development of the prune was one of the things that first engaged my attention.

THE STANDARD PRUNE

The Sugar prune had no real rival until the Standard was produced. This is a cross between the Sugar and the Tragedy prune. It combines the good qualities of both parents, and has the very important quality of being a freestone, the stone being so loose in the cavity that it may be heard to rattle when the ripe fruit is shaken. In exquisite flavor when dried, no fruit of any kind surpasses it. (Natural size of well-grown specimens.)

This work began about 1885, when I was growing seedlings of the European plum, *Prunus domestica,* from which practically all the prunes have been developed.

I have told in an earlier chapter of the success that ultimately attained the effort, through the development of the sugar prune. Here I wish to tell a little more at length of some of the tentative efforts and partial successes that paved the way for the final realization of an ideal.

As already told, these experiments were conducted by hybridizing the French prune with the larger and handsomer but less sugary variety known as Pond's seedling, and in California often called the Hungarian prune. The little French prune was selected as the parent tree and many thousands of blossoms were pollinated from the Hungarian. This was in 1885.

Four years later, at the meeting of the California State Horticultural Society, I had the pleasure of exhibiting fruit of seventy different varieties of these crossbreed seedlings.

During the next winter a purchaser of the commercial part of my nurseries, being ignorant of the value of these crossbred prunes, destroyed sixty or more of them. Fortunately, however, cions from several of the most promising had been grafted on older trees.

Among these selected grafts were two that gave much promise. These were advertised in "New Creations" of 1893.

The Giant Prune

In 1895 one of the new prunes was introduced as the Giant. It was so well received that four years later it was placed on the lists of fruits recognized by the American Pomological Society.

The Giant is a well balanced cross between its two parents the French prune (d'Agen) and the Hungarian. Fruits average 1½ to 2 ounces each and are of a sweeter and finer texture than the Hungarian but not so firm and sugary as the prune d'Agen. The large size, handsome appearance and rare keeping qualities place this among the best canning, shipping, and market fruits; but, unfortunately, the Giant follows its pollen parent the Hungarian in having a low percentage of sugar; so it does not cure well as a prune.

Here, then is a specific illustration of the tendency to revert to the characteristics of the plum and to give up the special qualities of the prune.

The Giant is a valuable fruit, excellent for shipping and especially good for canning. When placed in boiling water the skin immediately rolls

away from the fruit, leaving the rich honey-colored flesh ready for the can.

The plum has made its way to distant territories, and is now grown extensively in Australia and New Zealand, being especially prized for canning purposes.

In California it has proved a favorite and it is greatly superior to its staminate parent the Hungarian prune, especially for shipment.

But it is sold as a plum and not as a prune.

The Pearl Prune

Obviously, then, this was not the fruit I was seeking. But my experiments continued and after a few more generations of crossing and selection, I found among the seedlings one that produced a fruit in many respects more promising.

This fruit was introduced in 1898 under the name of the Pearl prune.

The Pearl prune originated as a seedling from the French prune. It is usually a little larger than its parent, but somewhat more flattened in form. The skin and flesh are pale amber and so translucent when ripe that the stone can be seen through them.

It is really a delightful prune, of exceeding high flavor, delicious aroma, and melting flesh,

THE CONQUEST PRUNE

At last, through successive selections and recrossings, a nearly perfect stoneless prune, which was named the Conquest, appeared. It was the result of crossing a partially stoneless plum with the French prune. This fruit, as here shown, has the good qualities of the French prune, and yet is almost entirely stoneless. It was introduced in 1912. *It is exactly like the common French prune in quality, and very much like it in appearance, though larger, and the tree is more vigorous and productive. Some growers object to it because, being stoneless, it does not weigh as heavily when dried.* (*About one-eighth larger than life size.*)

surpassing even the true Green Gage plum. No prune excels it for attractive fragrance. When cured it produces one of the most delicious of prunes; but it requires care in handling, since it does not cure well in the open air. Its chief fault is that it is not very productive, although healthy and vigorous.

It was sold to a New Zealand firm for introduction in the Southern Hemisphere in 1898. I myself introduced it in the Northern Hemisphere.

The New Zealand nursery company recommends it for that country in a recent catalog as follows:

"Pearl:—Raised by Luther Burbank. A seedling of the well-known French prune, which it surpasses in size of fruit. It is very handsome, flattened ovoid in form, white, semitransparent, with a heavy bloom. In honeyed sweetness, combined with a peculiarly attractive fragrance and flavor it excels all other prunes or plums. It requires care in handling, and will not cure well in the open air. It is especially recommended for market and home use when fresh."

The following quotation from "The Plums of New York," written in 1910, shows how this variety was regarded in New York at that time:

"The variety now under notice is one to be pleased with if it came as a chance out of thousands; its rich, golden color, large size, fine form, melting flesh, and sweet, luscious flavor place it among the best dessert plums. In the mind of the writer and of those who have assisted in describing the varieties for 'The Plums of New York,' it is unsurpassed in quality by any other plum. The tree characters, however, do not correspond in desirability with those of the fruits. The trees, while of medium size, and seemingly as vigorous and healthy as any, are unproductive here. In none of the several years they have been fruiting at this Station have they borne a large crop. If elsewhere this defect does not show, the variety becomes at once one of great value.

"The fruits of Pearl are said to cure into delicious prunes—to be readily believed by one who has eaten the fresh fruits. This variety ought to be very generally tried by commercial plum growers and is recommended to all who grow fruit for pleasure."

Other Partial Successes

Another prune developed somewhat earlier was named the Honey prune.

This was one of my earlier seedlings and not a hybrid. It was of better quality and hand-

somer than the Green Gage, the standard of excellence at that time. The tree was not remarkably productive, but the variety has been welcomed as a home fruit in several localities of California. It was not considered worthy of general introduction, but a few trees were sold to local growers who were interested in this variety and felt that it met the demands of their locality.

A seedling of the prune d'Agen which I called Miller, was sold to Leonard Coates of Morgan Hill, California, in November, 1898. This he introduced in 1908 as the "Improved French Prune." Later the name was changed to "Morganhill."

The introduction of this prune as described by Mr. Coates himself furnishes an illustration of the length of time it usually takes for the public to become accustomed to a new fruit. In a letter Mr. Coates says:

"We did not attempt a system of advertising in the start, but rather tested it thoroughly for some ten years or so. It is very hard to introduce any new fruit as so many have been put on the market without real merits. Fruit growers, however, appreciate to a considerable extent the value of selecting good varieties of fruit to propagate from. It seems that the chief introduc-

tion of pedigreed stock has taken place since our present nurseries were located and advertised on letter heads, etc., as specializers in pedigreed stock.

"The Miller prune which we now call Morganhill has been coming under the head of pedigreed prunes. We called it in the first description 'Improved French.' Very few people had enterprise to buy these trees at any increased figure and now we are propagating them at the same price as any kind of prune tree. About half the people seem to ask for pedigreed prunes and the others simply say 'French prunes.'"

This, then, suggests a measure of success. It constituted at least a good beginning.

Successes more unqualified were to follow; but the work just described was instrumental in laying the foundation for the later improvements—improvements that culminated in four prunes, one of which is already revolutionizing an entire industry, while the others have intrinsic values at least as great.

An account of these perfected prunes will be given in the succeeding chapter.

FOUR BURBANK PRUNES AND THE WORK BEHIND THEM

Revolutionizing an Entire Industry

A BRIEF outline of the story of the sugar prune was given in a chapter of an earlier volume.

The preceding chapter gives further details of the quest of a perfect prune.

The present chapter will treat more of results than of methods, and to present somewhat in detail the characteristics and merits of the four nearly perfect prunes that have been produced as the result of my long quest.

While some of the details here presented appeal rather to the orchardist than to the general reader, yet the story as a whole will be found not without popular interest. The fact that the growing of prunes is an industry of great significance, and that the fruit is everywhere an important commercial product would furnish ample excuse, were excuse needed, for entering somewhat more into detail as regards the specific

qualities of my quartet of prunes than has been done in the case of most other of my plant developments.

The Splendor Prune

Another prune of the same parentage with the Giant (referred to in the preceding chapter), namely, the Hungarian prune, crossed with prune d'Agen, was advertised at the same time, under the number "A. P. 318" in "New Creations" of 1893. This was purchased by Stark Brothers of Louisiana, Missouri, who procured the entire stock for $3,000, and named it "Splendor."

This prune is very much larger than the common French prune, is oblong, has a rich violet-purple skin, and the flesh is exceedingly sweet, and black when cured—a great advantage. The American people have been educated to black prunes and generally prefer them to those of lighter colors, following the fashion set by the French smoke-dried prunes. The Splendor fully answers the desire on the part of the buyer and consumer for a "black" prune, of large size and superior quality.

Splendor prunes, when cooked, require little sugar, containing about five per cent more sugar than the French prune, its quality and flavor are

superior, and it has a perfectly free stone smaller than is usual with prunes.

It ripens here two weeks earlier than the French prune.

The tree is even more productive, it is a more constant bearer, and is sturdier than its French parent; it is a well proportioned one, requiring but little pruning. The fruit is borne in clusters commencing low down on the body of the tree.

Many thought that this excellent prune would soon completely displace the prune d'Agen. Surely if quality and productiveness were all that were demanded by the grower, this would have occurred.

But Splendor has one peculiarity which places it at a serious disadvantage for general commercial purposes as a drying prune; the fruit clings to the tree when ripe, where it gradually dries into a delicious, sweet prune.

As prune growers like to have the prune fall as soon as ripe, to save trouble in harvesting, the clinging of the Splendor to the tree is considered a more or less serious fault. However, it is quite commonly planted wherever the German prune thrives, and gives excellent satisfaction, except for the extra trouble of picking.

It is shipped East as a fresh plum from sections of California in large quantities and is un-

usually well adapted to shipping, on account of its large content of sugar, making a fruit which carries well.

The Sugar Prune

The Splendor was the best prune I had heretofore produced, but it clearly left much to be desired.

It was with intense satisfaction that I was able to offer in "New Creations" of 1899 a prune that at least approached the realization of my ideal. This was another seedling of Petite d'Agen.

It was christened the Sugar prune, as it contained when cured 23.93 per cent of sugar—more than any prune or plum ever before known.

For fourteen years I had labored to produce a large, early, productive, handsome, easily cured, richly flavored prune with a high percentage of sugar. The prize appeared in 1893, and by 1899 I had tested it sufficiently to warrant its introduction. Numerous growers had ordered $50 to $500 worth of wood for grafting—regardless of the quantity—even before grafting wood was offered.

I had worked diligently and unceasingly, watching for the slightest indication of variation in the direction desired. Finally through systematic crossing and careful selection, my cherished desires were realized—after years of

persevering effort and patient waiting—in the Sugar prune.

In this, at last, I found a prune possessing the best qualities of all the prunes combined in one; and several of these qualities were intensified.

The Sugar prune had no rival until the advent of the still newer prune, the Standard, which I introduced in 1910.

When the selection of seedlings was made from which the Sugar prune originated, about one-half were at once discarded. Only those were saved which had the customary indications of good fruiting—large leaves, prominent buds, and strong, heavy wood with short joints.

Grafts from the young seedlings were placed upon Japanese plum stocks. This was done because there was no other stock at hand at that time. It proved to be a costly experiment, because more than half of these new, promising seedlings died before bearing fruit. Some of the grafts did not start at all; some made a short growth and died the first season; some grew a few seasons and died. Fortunately, however, some thrived as well as on their own roots.

The grafts that bore the first fruits of the prune which was later named "Sugar," made a fair but not a good union with the Japan plum. Although the first fruits of this variety were

borne on Japanese plum stock it is not recommended that Sugar prunes be grafted upon such stock. Roots of the peach and myrobalan plum make better stocks. Almond roots are also highly commended by some orchardists.

The seedling bearing the Sugar prune yielded its fruit the second year after grafting.

At that time I had the French Robe de Sergeant and German and Italian prunes growing on my Sebastopol place, and it was with these that the Sugar prune was compared. It proved to be superior in all respects to any of them.

Some of the fruits from the other grafts of this same lot of seedlings bore good plums but not good prunes. The fruits of the others had various faults, such as cracking, too large pit, clingstones, poor drying qualities, late ripening, scant foliage, or susceptibility to disease.

Several years are always required for the merits of a new fruit to gain full recognition, but the Sugar prune has gained pretty steadily in popularity. More and more growers are working their orchards into this variety, and it is taking the place it deserves, high among the leading prunes of commerce, especially as the tree is a tremendous grower and bearer and is also a good shipper and is proving to be one of the most acceptable fresh fruits in the eastern

markets as well as extremely profitable when cured.

The growers at Vacaville, California, the most important early fruit shipping center, became more enthusiastic as they saw the fruiting of these trees, the ease with which the larger prunes can be harvested, and the greater price per ton. About 2,500 new trees of this variety were planted in Vaca Valley in 1913.

Growers there received $17 to $25 per ton more for Sugar prunes in 1913 than for French prunes grown on the same farm at the same time. One of the growers reports that his French prunes averaged fifty-seven to the pound last year—when cured—while his Sugar prunes averaged thirty-nine per pound. The larger prunes always bring the best prices.

Not only did the Sugar prunes bring exceptional prices, the whole crop was dried perfectly, while the French and Imperial prunes, ripening later, were caught by the rains and many of them spoiled. The Imperial prune often dried to almost nothing but skin and stone.

One pound of green Sugar prunes makes seven and one-half ounces of dry fruit. It contains six per cent more sugar than the French prune and is far superior to it in flavor. It is so much more productive that it may be grown for

ONE OF THE PLUMCOTS

This remarkable fruit was produced by hybridizing the Japanese plum and the apricot. Most plant breeders held that so wide a cross was impossible, and this successful combination was not effected without difficulty. The story is told in detail in the text. The hybrid product is virtually a new species, of which there are now many varieties.

less than half the cost of producing the French prune.

The Sugar prune has a great advantage over the other varieties in ripening early in August, two weeks before the French prune, and about a month earlier than the Imperial. It ripens at a time when the weather is hot and dry, so that it can be cured bright and glossy in a short time and before there is any danger from fall rains.

A month or so later, when the last of the older varieties are maturing, the weather is often cloudy and foggy, or sometimes even rainy and in any case the days are much shorter, so that curing is carried on under difficulties, often (as in the cases just cited) with serious loss.

In 1912, prune shippers estimated that rain damaged the crop of French prunes in this county 25 per cent. The Sugar prunes were all cured and packed before the rains, so there was no loss of this variety.

Progress of the Sugar Prune

The fruit of the Sugar prune is usually even in size and very large, averaging thirteen to fifteen to the pound fresh, which is at least two to three times as large as the French prune grown here under the same conditions.

It has excellent curing qualities, standing the lye bath better than most other prunes.

The tree is very far superior to the French prune tree in every respect; better growing, better bearing, better foliage, better form. It requires less careful but abundant pruning; and it will carry and mature more than double the quantity of fruit.

The wood is somewhat brittle, but the chief cause of the breaking of the limbs, which sometimes occurs, is prolific bearing. It must be thinned when the fruit is about half grown, to prevent damage to the tree.

I have found that a very satisfactory and simple device for doing this is to tap the limbs gently with a piece of ordinary three-quarters inch rubber hose five to six inches long, fastened on the end of a bamboo pole. The hose causes no injury to the branches, and, by striking just hard enough, the fruit can be made to fall evenly and leave the amount desired.

The need of thinning, however, may be largely obviated by proper winter pruning.

When this variety was first offered, grafting wood was sold at $10 per foot. That the investment was a profitable one even at that price is shown by the following quotation from a letter written by one of the first purchasers:

"I was one of the first to introduce this fine fruit into our locality, the first year the grafting wood was placed on the market. I bought seven feet of wood for $70. The same was grafted into Tragedy prune trees, using one bud for each cion. The following fall and winter I sold about $600 worth of buds and cions from the ten trees which I had grafted with the Sugar prune cions."

The Best Prune—the Standard

Preeminent as are the qualities of the Sugar prune, there is always room for improvement.

I endeavored to make such improvement by the usual method of crossbreeding.

About 1897 I combined the Sugar prune with the Tragedy. There were only twelve or fifteen seedlings from the cross. But these were carefully grafted upon older trees, on larger branches where they would be in less danger of injury. This, of course, made the bearing of fruit a year later than if they had been placed upon the smaller branches. But it seemed worth while to wait for fruits of such high promise.

The whole tree was given over to each of the seedlings. Nor was this exceptional solicitude unavailing. For among these carefully nurtured cions was one that bore a fruit that surpassed even the hitherto matchless Sugar prune.

After a period of trial, in which it met the severest tests, this superlative prune was introduced as the "Standard."

It is rather curious to record that, with a single exception, all the remaining cions of this patrician sisterhood have proved wholly worthless as prunes. But that, of course, was a matter of no consequence. It sufficed that one cion came to fruitage with a paragon of prunes.

The Standard prune far surpasses the Sugar prune in quality. It also has a stone that is entirely free from the flesh, being the first prune ever produced that combined superior qualities of flesh with this desirable characteristic.

In the opinion of a number of the best known growers, it is the best prune ever produced. The trees are enormous and never-failing bearers, and good, healthy growers, better than the French prune though not as strong as the Sugar. Well-grown fruits measure nearly six inches around one way by four and a half inches the other.

On old standard orchard trees the size may average larger than this, but when the crop is not too heavy the fruits are really enormous.

The skin is purple with a heavy blue bloom flesh honey-yellow, fine-grained, juicy, yet firmer than most drying prunes, and very sweet

The stone, which is free, is only five-eighths of an inch in cross section and very thin.

The Standard is without doubt the best combination drying and shipping prune ever produced. It ripens with the French prune in September. It has been kept fully a month in good condition in a basket in an ordinary living room during our warm fall weather. It can be successfully shipped after it becomes dead ripe to any part of the United States.

And the final test as a prune is that when dipped in the ordinary lye solution the skin cracks properly, so that the result is a big, quickly dried prune of superlative quality.

The following comparison of the French and Standard prunes, made by G. E. Colby of the University of California, gives a good idea of the value of the Standard prune:

	Average The Standard	French Prune
Average weight in grams	49.7	23.6
Number per pound	9.1	19.1
Flesh, per cent	96.5	94.2
Pit, per cent	3.5	5.8
Sugar, per cent	18.9	18.5

In case anyone wishes to change a prune orchard over to a more profitable variety, whether for drying or shipping fresh, I would strongly recommend the Standard for grafting.

The Standard was offered to orchardists in my catalogue of 1911-1912. The trees were sold at $3 each, and thousands of trees have been distributed, but it will be a good many years before the real value of this superior prune is fully appreciated.

Clinging versus Freestone

One of the most striking individual peculiarities of the Standard prune is its freestone quality, already referred to. The development of this character is of such interest and importance that it calls for more than passing mention.

At first, it is very probable, all fruits were clingstones. The stone was probably firmly attached to the flesh from the time of the forming of the meat to the final decay of the fruit. The stone in fruit acts as a support to the flesh, to which it is attached and around which it grows.

The clingstone feature was evidently an advantage to the fruit, as plum and prune seeds will not germinate if thoroughly dried, and the clinging meat in most of the fruits keeps the seed moist for a longer time, thus helping to conserve its vitality until the proper season for germination.

Where the flesh is attached to the pit, the circulation between the pit and the surrounding

flesh is less interrupted, probably an advantage to the development of both.

The clingstone is thus the more normal condition of fruits. Most fruits are clingstone until brought under cultivation. All fruits, both wild and cultivated, are clingstone until toward the time the ripening process commences.

That many cultivated fruits are freestone is no doubt the result of artificial selection to meet a very natural demand.

Nuts furnish analogies that help us to understand the relations of seed stone and fruit. The case of the almond, which was perhaps more nearly the parent form of stone fruits, is particularly instructive. In place of the rich surrounding meat which we see in peaches, apricots, and plums, the almond has a leathery skin, which is inedible. This generally clings to the stone persistently in the wilder forms, but with the best cultivated almonds the nut drops readily from the husk or outside covering.

Similar to the persistency with which the flesh of the plum clings to the stone is the attachment of the husk in the walnuts and the chestnut, in each of which the husk separates with more difficulty in the wild than in the best cultivated varieties.

A SUPERIOR PLUMCOT

This delicious plumcot, as yet unintroduced, possesses marked freestone characteristics, a quality very unusual among the Japan plums that figure among its ancestors. Apricot parentage is indicated by the smooth stone and by the shape and ridging of the fruit. The flesh, by its red color, shot with yellow, indicates plainly the Satsuma plum, modified by apricot influence. As an example of mixed inheritance, therefore, the fruit has exceptional interest. The fruit appeals to any palate.

From the standpoint of protection and reproduction of the almond, the clinging husk is an advantage rather than an objection. The seed of the almond will germinate after being thoroughly dried. It needs no flesh to tide it over, as do the pulpy stone fruits. But for man's use the clinging husk is a disadvantage, and the clingstone habit has been eliminated in all the best cultivated varieties of the almond.

In the plum a similar change has been developed by selection. The meat does not cling to the stone in many cultivated varieties. In the almond the quality of the meat has been greatly improved, while the husk or immediate covering has not been improved in any respect, as no use is made of it.

Even a freestone fruit does not start as a freestone, but the flesh tends to leave the stone as the fruit approaches maturity, very much as a leaf ripens away from its supporting stem in the fall when it has performed its annual function, or the fruit parts from the tree when it is fully ripe. The flesh parts from the stone by a natural process. This leaves the stone either "free" or partially free.

Some individual trees among a lot of seedlings—chestnuts in particular—will hold their leaves persistently all winter (this persistence is

especially common with crossbred chestnuts) even when thoroughly dead and dried, giving an untidy appearance to the tree, while the leaves of other seedlings fall at once and leave the branches clean and free.

This is a similar process to the parting of the flesh from the pit in fruits, both being ripening processes.

There is every gradation between the complete attachment we call "clingstone" and the "freestone" condition. In some fruits there is a single point of attachment; in others the flesh adheres over a part of the surface while the remainder may be wholly free from the stone.

There is also another form of partial separation found in some fruits where the flesh clings tenaciously to the stone until fully ripe, when it parts readily, while in others it may separate from the fruit and be shaken about within it even before thoroughly ripe.

There seem to be two forms of variation, one in the time of attachment and the other in the persistency of attachment.

This persistency of attachment varies greatly; in some fruit it would be possible by a little work to cut around the stone and in others the flesh is attached so closely that to remove the stone satis-

factorily you must have sharp tools and use them with discretion.

The old hereditary tendencies make it difficult to change plum and prune heredity so that it will produce freestones instead of clingstones. Nevertheless this has been accomplished with several varieties, including the Standard prune.

Of late the canners have preferred the clingstone peaches mostly, perhaps because they have a firmer flesh that does not fall to pieces when cooked, as the freestone peaches generally do. The pit is very easily removed with a sharp instrument made for the purpose. With this exception, fruits are generally more valuable when they are freestone.

The Conquest—A Stoneless Prune

But what if the fruit had no stone at all?

That would, indeed, be the ideal condition. And this ideal is met in the fourth member of my quartet of best prunes—the Conquest.

This, the newest of my prunes, was first offered in the catalogue of 1911-1912.

The work of producing the stoneless prune parallels that of the production of the stoneless plum, a preliminary account of which has already been given, and fuller details as to which will appear in the succeeding chapter. Here it is

necessary to mention only such aspects of the work as refer specifically to this prune.

The Conquest was produced by crossing a partially stoneless plum in my orchard with the French prune.

The difficulty of getting a stoneless prune was about equal to the difficulty of getting a satisfactory stoneless plum. If I had crossed with a plum it would have been a hundred times more difficult to get the prune characters than it was to get stonelessness.

In the Conquest the size and quality of the French prune is retained or even intensified, together with the stonelessness of the other parent. This cross brought out both prunes and plums—some of the largest plums ever seen. At first they were all blue like the stoneless parent; later they took on all the colors of ordinary plums.

The advantages of the stoneless prune are too obvious to require elucidation.

To be sure, the new prune is not in every case absolutely stoneless. A small speck often persists in prunes of best quality. It has been no great trouble to totally eliminate the stone in a poor fruit; to combine stonelessness with good quality of fruit has been extremely difficult. But continued selection has finally produced a prune

of this kind which has the quality of the best French prunes, together with entire stonelessness.

By Way of Summary

Such, then, are the four Burbank prunes that are the pick of all those that have been developed on my experiment farms.

The methods used in their production are similar to those used in the development of the four best Burbank plums as told in an earlier chapter. The distinctive qualities of the four prunes themselves may be summarized thus:

The Splendor prune is large, productive, has high sugar content, has a small free stone and ripens early, yet has the fault of clinging to the tree.

The Sugar prune is very large, productive, very early, superior in tree form, an especially good curer, and is both a sure bearer and a sure seller.

The Standard prune has most superior quality of flesh, is entirely freestone, and in general is the best combination drying and shipping prune thus far produced.

The Conquest prune is similar to the French prune in quality of flesh, but better, and has the stone brought down in size to a mere speck, and the tree is far more vigorous and productive.

Because of the many characters it is necessary to combine in producing a successful prune, it is probable that the work represented by these four varieties is fully equal to the production of ten times that number of standard plums—with, probably, proportionate benefits.

But from the almost numberless varieties, the result of years of selective breeding, there will probably arise individuals year by year that will present new and superior combinations of qualities; and among these may appear at any time a prune that may even surpass my best prunes of the present as markedly as these surpass their predecessors of a generation ago.

This, indeed, is fully to be expected. Each of my prune trees, with its colony of selected hybrids, may be regarded as a factory admirably equipped for the turning out of new varieties of prunes. Even though it were left to be operated solely by the bees, its mechanism has been so perfected, its equipment is so complete, that it can scarcely fail of its purpose.

PLUMS AND PRUNES WITHOUT STONES AND SEEDS

How All Fruits May Become Seedless

A NUMBER of years ago a distinguished pomologist who was not in the secret of my newest plant development, visited my place at Sebastopol in company with the eminent botanist Professor Hugo de Vries.

Standing by one of the plum trees, de Vries asked his friend to cut through a plum and examine the stone.

Then with obvious amusement he watched the pomologist work his knife carefully around the center of the plum—to avoid a stone that was not there.

As he told of it afterward, he declared that even the boots of the pomologist indicated surprise when the knife cut at last through the center of the plum without meeting any obstruction.

This was a case in which a man's surprise would be somewhat proportionate to his knowl-

edge of botany and plant physiology. The more he had studied the subject, the better he would be able to appreciate what stonelessness in a plum really means. The more he had worked in plant development, the fuller would be his appreciation of the labor represented in the reproduction of this anomaly.

And my visitor, being both a botanist and a plant experimenter, was certainly greatly surprised.

What the Stone Means to the Fruit

The story of the development of the stoneless plum has been told in an earlier chapter.

It will be recalled that I worked primarily with a small, partially stoneless plum that was found in France—a sour, acrid fruit of no interest except for its partial lack of seed covering I crossed this inedible fruit with a cultivated plum, and selected and recrossed through successive generations until I had segregated the characters of stonelessness and good quality of flesh and reassembled them in a single individual.

Further mention of the development of the stoneless prune, through crossing the stoneless plum with the French prune, with the ultimate production of the Conquest prune, was given in the preceding chapter.

Here it is not necessary to repeat the details of the method through which the stoneless plums of various kinds, including the prune, were developed. It seems desirable, however, to examine at some length the relations that obtain between the stony seed covering and the general and especial needs of the plant; and to correlate this type of seed covering with other type of protective seed covering that serve the same or a similar function in the case of other tribes of plants.

When man takes a plant under his care, some of its many parts may become of little use, because of the changed conditions of the artificial environment.

Thus the wild oat has a pointed, sawlike beard, which, turning and twisting under influence of moisture and heat, helps the seed to burrow into the earth. This is obviously useful to the plant in a state of nature. But it becomes a useless piece of baggage when the plant has been tamed and grown by man, for man will see that the seed is planted in return for the crop it yields.

The blackberry, domesticated, has no further use for the thorny armor that was originally developed to protect it from destruction by animals that would browse on its leaves and stems or trample it to death.

In the same way the cactus, when taken under cultivation, can dispense with the spines that were so necessary a protection to it while it grew in the desert, where, in the old days, buffalo and antelope, and in more recent times cattle and horses, would feed on its succulent slabs were they not carefully guarded.

The apple, pear, and plum, which armed themselves with sharp thorns when in the wild state, have given up the thorns since they came into the orchard.

Among other families of plants we find that protection has been secured by the development of acrid or astringent or poisonous properties, offensive odors, or imitative colors that serve no useful purpose except to safeguard the plant against its enemies. And such protective devices and mechanisms often become a burden when the plant is brought under the guardianship of man.

Of a piece with these protective devices is the peculiar covering that the plums and their allies have developed about the seed that grows at the heart of their fleshy and succulent fruit. This stone is like an armor-plate covering that successfully protects the seed from the action of even the strongest jaws, or from almost any forces of nature to which it is likely to be subjected.

Possibly one reason why the stone fruits have developed this unusual seed covering is that each fruit of this family bears but a single seed. The many-seeded apple does not need to protect its seeds quite so jealously; but the plum, with its single seed, can afford to take no chances of the destruction of that seed.

The case illustrates a familiar principle of nature. Everywhere it is observed that the more prodigal the supply of reproductive mechanisms, the less the seeming care with which they are guarded. Among forest trees that are fertilized by the action of the wind, pollen is produced and wasted by the ton. But in flowers pollinated by insects, relatively small quantities of pollen are produced, and its distribution is carefully prepared for by the auxiliaries of color and fragrance and nectar which guide the pollen-distributing insects.

The mustard produces thousands of seeds for each plant, and it does not even take the trouble to imitate the grains of other plants, in size and form, as some of the seeds are obliged to do in order that they may be distributed with the grain when grown.

The peach, on the other hand, produces but a single seed for each flower and fruit, and armors that seed with so strong a covering as to make

it difficult for the germinating cells to make their exit when the time comes for their development.

Thus these stone fruits conform to a great familiar principle of nature. Their exceptional covering has been developed by natural selection to insure continuance of the species under natural conditions.

But it is obvious that, now that man has taken the plant under his care, the species will be perpetuated with his aid, and hence the extraordinary armor about the seed might well be dispensed with. But as a matter of course the plant cannot drop all at once a structure that heredity and environment have worked thousands of years to build up.

Man cannot take the Indian and say to him: "Be civilized," and expect him in a generation to drop the tendencies that have become a part of him through centuries of inheritance.

The hunter cannot take the wolf and by treating him like a domesticated animal make a dog of him in a single generation—even though the ancestor of the dog was a wolf. And similarly when the fruit grower takes the plum under his protection, he cannot hope that this plant will give up at once the protective device that has served it so well in the long past.

Heredity will have its say, and the seed armor will persist long after it has ceased to be of real utility.

The Stone Becomes an Incumbrance

And yet it is easy to see that under conditions of artificial cultivation, the stone is not merely useless to the fruit; it is a positive incumbrance.

In the first place it puts a tax upon the vitality of the plant—makes a strong draft on its energies. A plant is a manufactory for transforming elements of the soil and of the air, under the influence of sunlight, into grains, fruits, gums, essential oils, and the like.

Its capacity to produce any one of these is more or less complementary to its capacity to produce the others.

When the cultivated plum produces a useless stone, it has worked to no purpose; and the energy that goes to build the stone might far better have been utilized, even from the standpoint of the plant itself, in the production of fruit.

For the perpetuation of any given race of cultivated fruit plants now depend not upon the character of its seed covering but upon the appeal made by the pulp of the fruit to the palate of man.

So the stone not only destroys a part of the usefulness of the plum for man directly, by its presence in the fruit, but it is also indirectly harmful in that it hampers the vigor of the tree in the production of foliage and larger quantities of fruit.

Yet when the plant improver attempts to remove the stone that has thus come to be an incumbrance to the plant, he is obliged, as it were, to swim upstream against the hereditary current of the ages. Ten, fifteen, twenty years—these are but moments of time when working against tendencies that are fixed by thousands of repetitions under conditions that remained unchanged for numberless generations, and until the immediate present.

Bearing this in mind, we gain a more vivid impression of the difficulties that confront the plant developer who would endeavor to relieve the plum of its burdensome stone.

Aid from Nature

But here as elsewhere nature will sometimes seem to forget for a moment the very fundamentals of her plan; and through such a lapse the hereditary mechanism of a given organism may be changed more radically, perhaps, in a single generation, than it could be changed by almost

any number of generations of selective effort on the part of man.

Such a lapse was made, we do not know just when, in the case of a minor variety of plum that chanced to grow in central Europe. Through this momentary lapse in nature's memory, this plant found itself with a seed for which the customary stony covering had been nearly half forgotten. Only about half remained of the shell that to plum seeds in general is as a veritable armor plate.

The plant that suffered this strange mishap was, as the reader already knows, a little French bullace of small significance, known as the *sans noyau.* Of course we must not be supposed to imply that the relative importance of this particular member of the plum tribe had anything to do with its mishap. The laws of heredity apply quite as rigidly to the most insignificant as to the most important of plants. Indeed, it is scarcely within man's province to decide as to which plants are really insignificant and which important in the scheme of things.

But at least it may be affirmed that, according to ordinary human standards, the little bullace was of a most inferior type. Yet, paradoxically enough, it became, in virtue of its misfortune, the most important race of plums in the world.

For without the aid of this apparently malformed variety, the plant developer would have had no leverage with which to attack the problem of relieving the great family of stone fruits of their now useless and even obnoxious seed covering.

The malformation of the little bullace, through which it lost its seed protector, would doubtless have resulted under conditions of natural selection in exterminating the species.

But the same transformation which would thus have worked destruction in a state of nature, sufficed to make sure that, under the changed conditions of artificial selection, this particular plum should become the progenitor of all the plums of the future.

For we can little doubt, now that the stone has been taken from a few varieties of cultivated plums and prunes, that all other varieties will ultimately be brought into the stoneless coalition. And the only feasible way to bring this about will be to interbreed one variety after another with the descendants of the little stoneless bullace.

The plums of the future will be diversified in form and size and quality.

They will draw their chief ancestral traits from the plums of Japan or China or Europe

or America, or from a blending of these strains.

But each and every one of them will have the little *sans noyau* for one of its ancestors, and will owe to that plebeian ancestor the quality of stonelessness which will be regarded as one of its best prized characteristics.

A Retrospective Glance

In this view, then, the stoneless plum may be considered perhaps the most interesting of fruits.

Possibly a future even more important than that just suggested may be in wait for it. It is at least within the possibilities, as hinted in our discussion of the peach, that the quality of stonelessness may be extended from the plums to the allied tribes of stone fruits by hybridization.

Conceivably the descendants of the little bullace may include not only the races of cultivated plums, but even all races of apricots, peaches, and plumcots and cherries as well.

But even though the view be confined to much narrower limits, it still remains true that the stoneless plum is among the most important of all plant developments. So it may be worth while even at the risk of a certain amount of repetition to review the history of this develop-

ment, and in particular to add a few details that have not hitherto been presented.

It will be recalled that the little *sans noyau,* despite its name, was not altogether stoneless, inasmuch as each fruit had a covering of stone more than half way around the kernel; also that the fruit itself was only about the size of the ordinary cranberry, and was harsh, acrid, and unpalatable.

Yet when this unpromising fruit was crossed with the French prune, and with numerous other plums and prunes, some of the crossbred seedlings produced fruit larger than the French prune, and nearly all of the hybrids were superior to the wild parent.

All the seeds of these hybrids were carefully saved and planted. The seedlings were grafted on older trees, and a few seasons later still better ones were obtained; plants bearing larger fruits and many of them showing the tendency to abandon the stone.

The first generation hybrid seedlings of this type, which were quite numerous, had mostly the French prune for the pistillate parent. Some, however, were from the reciprocal cross.

Of the latter, the crooked thorny seedlings which indicated that they were not crossed, or had reverted to the wild type, were generally

destroyed even if they bore stoneless fruit. Those which showed the French prune or ordinary plum type were grafted into older trees to bear.

All the seedlings from the cross of the *sans noyau* pollen upon the French prune were grafted and fruited even though many of them exhibited the thorny, dwarf, ill shape of the wild parent.

After the first generation the seeds of all were mixed, as there seemed no object in keeping them separate. For two or three generations there were all sorts of trees, the greater tendency being toward the bullace, which, being a wild type, would naturally be expected to have its characters more thoroughly fixed.

In the first generation some plums were obtained fully twice as large as the fruit even of the cultivated parent. But most of these had stones, and were, moreover, soft, sour, undesirable fruits.

All but a few of the more promising grafts were removed from the trees, and the experiment was continued with the selected ones.

In the next generation there was some general improvement in the growth of the seedlings and the size and quality of the fruit. And in later generations the quality of the fruit rapidly

improved—combined with stonelessness—until I obtained two or three fine plums and prunes.

These were grafted extensively and seedlings raised and selected for still further improvement.

Some of the earlier results of these experiments were exhibited at the Pan-American Exposition at Buffalo, New York, in 1901, and aroused much interest among fruit growers. None of these, however, was worthy of introduction as a commercial fruit.

The plum called Miracle was the first of the stoneless plums to be introduced.

This is borne on a rather slow-growing tree and has the size, flavor and appearance of a small Damson, being about an even balance between the French prune and the original *sans noyau* in most of its characters. Some years it is quite productive, but it is not an altogether dependable bearer.

A representative of the Oregon Nursery Company, on a visit to my Sebastopol grounds in 1903, was greatly pleased with this variety, and at once purchased it. It has been advertised and grown quite extensively. Its flesh is of such quality as to be chiefly valuable for the making of jam.

At that time it was the best stoneless plum in existence. But its chief merit was that it was

the forerunner of a race of stoneless plums and prunes which will in time be grown wherever these fruits are raised.

The Stoneless Prune

The next stoneless variety to be introduced was the prune named the Conquest, with which we have already made acquaintance. It will be recalled that this is one of the quartet of best prunes described in the preceding chapter.

From 3 per cent to 6 per cent of the bulk of the French prune is stone. The specks of stone that remain in the Conquest do not constitute more than one-thousandth part of the fruit, which is thus edible practically without waste.

The Conquest was offered in my catalogue of 1911-1912 with the following description:

"There has been known for several hundred years a wild plum, an unproductive, thorny bush, which bore insignificant, acid, bitter, wild berry-like fruits with only half or two-thirds of a stone. Years ago it was hunted up in Europe with the plan in view of producing really valuable stoneless plums and prunes. The labor and expense incurred in these experiments have been enormous, but among the many thousand varieties, one really good stoneless prune was produced

and is here offered for the first time in the history of this earth.

"The tree is a vigorous, healthy, rapid grower and unusually productive. The fruit is very similar to its civilized parent, the common French prune, in form, size, color, and golden, sweet, rich flesh. The stone has been eliminated wholly with the exception of a tiny speck. The fruit is so very valuable and the tree so very productive that I have consented to introduce it this season. It ripens with the common French prune and is in all respects very much like it in size, quality, and appearance."

The French prune is nearly oval, but Conquest is slightly larger and more flattened in form, like some of the other prunes.

Further Improvement in Prospect

Among the later seedlings I found some very good fruits which have reverted to the stony type, one of them in particular being extremely large and of sweet, rich, superior quality.

Thus, after several generations of plums without stones, those having ordinary stones again appear. There are others, however, that retain the stoneless condition, and are of exceptional size. Every color of the plum now appears in these stoneless hybrids — white, pale yellow,

orange, scarlet, crimson, violet, deep blue, almost black, striped, spotted, variegated, and mottled in every way imaginable.

They ripen from the middle of June until Thanksgiving, and while some varieties are no larger than a cranberry, others are larger than any other plum now generally cultivated, except perhaps the Climax, the Wickson, and Kelsey.

After a time, no doubt, varieties may be produced with solid flesh throughout, as many seedlings now have indications of such a condition. The best stoneless plum thus far produced has a strong tendency toward this condition.

I am often asked how the present plum with stones and seed will be replaced by the stoneless variety.

Will the ordinary varieties be supplanted within a few years?

There is no probability of that. It will be a long time before our present orchards are replaced by trees bearing stoneless fruit. Long years of selective breeding have been required to give the plum its good qualities. To hold to present standards of quality and make the fruit stoneless as well, will require a great amount of time, patience, and effort.

Of course, with modern methods it can be done in a much shorter time than in the

past, but it must take a long time gradually to replace one and then another and another.

The replacement of the ordinary plum by the stoneless plum will come about gradually, somewhat as the red potato was replaced by the white potato in California. Twenty-five years ago nothing but the red potato could be obtained in any of the markets of this State. Even my own brothers questioned whether the Burbank could make headway against it. To-day more than five million bushels per year are grown in this State and red potatoes are not to be found.

The Outlook for Seedless Fruits

It will be remembered that there have been seedless raisins grown for a century or more, yet everyone knows that seedless grapes are by no means universal.

The well-known Washington navel seedless orange has made a new world market for this fruit. Yet the bulk of the oranges in the markets of the world have seeds. There are good seedless lemons, limes, and grapefruits; but they are very gradually finding their way into the markets.

The change from stone to stoneless fruit will come about by imperceptible steps. The change

will be so slow as hardly to be noticeable. Poorer varieties of all fruits are gradually replaced by the better; so gradually that the change is scarcely noticed.

Odd forms are constantly coming up in nature—like the little, deformed bullace that was the parent of the new stoneless plums. Sometimes their inherent prospective value is recognized—oftener not. A hornless animal appeared as a sport or sudden variation in Argentina half a century or so ago. Possibly this freak may have appeared a hundred times before. But in this instance some one having imagination noticed the mutant and fostered it, and we now have hornless stock from that Argentine variation, not only of the original but of nearly all breeds.

Among fruits, changes no less marked are constantly arising, and as time goes on these will be more and more recognized, and appreciated and used. As a greater knowledge of plant improvement is becoming disseminated, more pronounced changes for the better will be made—the elimination of stones and seeds being one of the most important of the many improvements required.

The appearance of the stoneless plum, not as a chance sport, but as the product of an arduous

series of hybridizing experiments, may be taken as a sure augury that the conception of an age of stoneless fruits is not illusory—however long its coming may be delayed.

Man cannot take the Indian and say to him: "Be civilized" and expect him in a generation to drop the tendencies that have become a part of him through centuries of inheritance.

PLANNING AN IDEAL PLUM OR PRUNE

The Requirements and How They May Be Met

When I was in the nursery business a man came to me on one occasion and wanted trees for his orchard. I showed him my stock, but it did not suit him. He wanted trees that grew six feet high before branching. I had nothing answering that description, so he bought elsewhere.

In a year or two his tall trees were sweeping the ground, quite as might have been expected. So the orchardist came to me to find out what he should do.

Naturally I told him he should have commenced right by getting trees of the right form at the outset. Now there was nothing for him to do but to cut his trees back to the right height, and let them start anew, thus losing two years of growth. He did not like this prescription, but presently had to follow it. Of

course, his trees were never as good as though they had been given the right start; but their new condition was an improvement on the old one.

This misguided orchardist was simply acting on the mistaken idea that was everywhere current until quite recently—the idea that it is necessary to run a tree into the sky so that other crops can be raised under it, and that teams can be driven close to the trees in cultivating. Nowadays the orchardist adapts the implements of cultivation to the tree, instead of adapting the tree to the implements.

Or, what is better, he adapts the trees to the land and makes the orchard pay better and with less labor, without attempting to raise any other crops in the orchard.

It has been discovered that skyscrapers in the orchard do not pay. A tree should be of such form that the fruit may be picked conveniently. It should not be necessary to use stepladders to gather the fruit from the lower branches.

In the case of the prune, in particular, a low-branching tree is especially to be desired, that the prunes may not get bruised in falling, for even as tough a fruit as a prune may be injured in falling from a tall tree.

Planning the Plum Orchard

The old way of planning an orchard was to look over a catalogue and order half a dozen of this or half a dozen of that, especially if the name sounded good, without asking any questions or gaining information as to whether the varieties selected were adapted to the region where they were to be grown.

And the old way for the grower or nursery man was to accept the form of the tree as it tended to grow, with little or no attempt to change it.

But the new way is for the intending orchardist to select his varieties with the utmost care, paying careful heed to questions of soil and climate, and introducing only such fruits as are adapted to the conditions that must be met. And as to the trees themselves, when they begin to grow, the modern plant improver is by no means content to leave everything to nature. He takes a hand from the outset, and largely determines the form of the tree.

Moreover, the up-to-date orchardist will look beyond the existing form, and recognize that it requires both imagination and labor to produce the ideal tree.

Building an ideal plant of any kind is like building a house. Each must be planned in accordance with a clearly conceived idea. But there is this great difference: In the case of the plant you must wait for nature to supply you with the material with which to build.

Plant building is architecture—but architecture with limitations. It is always slow and very often it is extremely disappointing, yet it has its encouraging surprises as well. Times without number I have been ready to give up an attempt to secure an improvement on which I had worked unsuccessfully for years, when, just as patience was at the breaking point, nature would seem to have a generous mood and, as it were, throw the desired characteristic into my lap.

What the blue print means to the architect, the conception of the tree or fruit or flower wanted should mean to the plant improver. It represents a precise ideal toward which to work, and it gives standards of comparison by which progress may be checked as the work progresses.

In the case of the plum it is possible to present the ideal to the mind with great accuracy. Of course it may not be possible to attain results strictly in accordance with the plan. But usually the ideal may be at least approximated if it has

been intelligently conceived, and if it is persistently borne in mind.

Specification for an Ideal Plum

Let us now note specifically and in sequence some of the practical points to be considered in planning our ideal plum.

In so doing we shall find that there is a certain amount of overlapping, or perhaps we had best say interference, of qualities. A plum that is best for one purpose may not be best for another. We must bear in mind the different purposes to which a plum is put, and endeavor to make our plan comprehensive enough to cover all of them.

There are certain qualities, to be sure, that are desirable in every variety of fruit. Large size, for example, and frost-resisting quality are seldom or never disadvantageous. Yet even this must be qualified, for, in case of a prune, drying becomes more difficult as the fruit enlarges, and unusual size may be a disadvantage. But for plums in general we aim at a tolerably definite combination of qualities—size, form, color, flavor and hardiness—and endeavor to associate these in the same fruit.

Taking up our ideal plum tree part by part, let us first consider the root.

This is of great importance. A great difficulty of the French prune is that its root system is ordinarily inadequate. It is usually necessary to graft this prune on other roots. Peach stock is sometimes used to advantage both for this and for other varieties of plum. But there are some plums that do not graft kindly on the peach, and it is necessary in such cases to make a double graft, using first a cion of some plum that grafts well on the peach, and then grafting on this the cion of the desired variety.

This is obviously a rather tedious procedure. Fortunately it has been discovered that the myrobalan plum furnishes good roots on which almost all plums may be grafted, and this stock is becoming very popular. The roots of the apricot are also sometimes used successfully. On deep, dry soil, almond stock often gives the best results with certain varieties.

But, of course, there will be great advantage if the plum can be made to grow a good set of roots of its own. It should be recalled that an abundance of roots is always closely correlated with abundance of foliage. One may tell at once in the orchard whether a tree has a good system of roots by observation of the foliage. And the close dependence of the roots on the foliage is a matter of common observation.

Many orchardists fail to realize how completely the roots are governed by the amount of foliage. And even when this is realized the observed conditions are not always correctly interpreted. If the foliage did not govern the roots, our orchard trees would be of all sizes and of all degrees of vigor, whereas now, when grafted on seedlings of varying degrees of vigor, the trees are uniform.

As to the stem of the tree, this should come up straight as a flagstaff, and should branch sturdily, the branches coming out not quite at right angles but turning slightly upward. Branches should not turn down, nor should they be crooked. Moreover, the branches should not tend to grow too long and slender.

Many seedlings tend to take on a bushy growth, which is undesirable. Others are too slender. Some have a general irregularity of growth, which is particularly objectionable. Brushiness invariably indicates a lack of production; it suggests a reversion to some inferior ancestral type. And it may fairly be predicted that the tree will show similar reversion as to fruit, producing a small fruit of poor quality.

Brushiness is indicated by slender, too abundant, poor branches instead of sturdy branches.

Slender branches can never be correlative with large fruit—they have not requisite strength.

That is one of the many reasons why I select seedlings with large branches, and those having prominent buds and large, thick leaves. These are all indications of a bearer of large fruit.

Large branches and large fruit are associated together through the effect of past heredity; just as, contrariwise, small fruit and small leaves and branches are the hereditary traits that are similarly associated with small fruit.

Of course, it is not always possible, in the present stage of orchard development, to secure a tree of perfect growth and form.

This is true not alone of plums but of other orchard fruits. Some of our best varieties of orchard trees, like the Bartlett pear, have branches too slender and upright, and do not carry the fruit well. The Bellflower, though a fine apple, makes a weeping growth. The Newtown pippin makes too slender and upright a growth. On the other hand, the Gravenstein apple makes a very fine, spreading tree, and the popularity of this variety may be to some extent associated with the almost perfect form of the tree itself.

But it is one thing to observe that a tree is imperfect, and quite another thing to take the trouble to improve it.

We know that the branch system should resemble a vase in form, avoiding brushiness, woodiness, or overgrowth. But many orchardists who are well aware of this will not take the trouble to prune the tree in such a way as to encourage this development; nor will they consider the matter of selecting a variety that tends to grow in the right way without pruning.

As to the leaf system, it is always desirable that the foliage of a fruit tree should be large, thick and abundant. Such leaves indicate ability for large sugar production.

In the case of cherries it is particularly desirable that the leaves should hang over the fruit to protect it from the weather and from birds. With the plum this is not so necessary. Still the question of foliage should always be considered. Other things being equal, seedlings should be selected that show large, thick leaves.

Blossoms and Fruiting

It is almost axiomatic to say that plum seedlings should bear perfect blossoms in reasonable abundance.

The blossoms should be borne on the larger wood of the tree rather than on the tips, because the fruit is held better where it has the support of the older wood. Moreover, if the fruit is borne

PLUMLIKE PLUMCOT

This is the plumcot named "The Bearer." At first view, the fruit gives the impression of a Japanese-American hybrid plum, but the short, thick wood, the prominent buds, peculiar bark, and especially the fuzz, indicate apricot parentage. The apricot characters are prominent in the tree; but the fruit is, on the whole, distinctly plumlike in general appearance.

at the tips of the branches, these are brought too near the ground.

The time of flowering should be given careful consideration in connection with the climate where the orchard is to be located. Many fruit trees bloom so early that in mild climates the late spring frosts injure them. In general, late-blossoming trees have an important advantage.

It should be understood that a tree that blossoms late usually matures its fruit early, whereas one that blossoms early will usually bear late fruit. This is, of course, precisely the reverse of what might be expected, unless we bear in mind the reasons for the difference. A moment's reflection makes it clear that late bearing and early fruiting should be correlative, being adaptations to a climate where the summer is brief.

The bearing season of the plum may be short or long according to the use to which the fruit is to be put.

Fruit that is to be gathered wholesale for the market should have a short season, the major part of it ripening at the same time. On the other hand, fruit for home use or a local market should have a long season.

But even more important is the matter of "every year bearing." A tree that never makes

a failure—one that bears annually and does not have any off years—is the kind of a tree that is needed. The orchardist naturally wants a tree that can be depended upon to give him a crop. A tree that sometimes balks after starting a lot of fruit, because the temperature or conditions of moisture are not just to its liking, is not the kind of tree that endears itself to the fruit grower.

It must be understood, however, that fullness of bearing has no necessary association with hardiness. The two qualities are quite distinct. A tree may have one quality and quite lack the other. It may be able to thrive under adverse conditions, but not to bear under adverse conditions.

The ideal tree, of course, is one that will not only thrive but will invariably produce a fair crop of fruit whether the season is hot or cold, dry or rainy. A fine practical test of fullness of bearing is supplied when a frost comes just after the blossoms have dropped, while the miniature fruit is fully exposed.

A tree that will stand this test may generally be depended on as an every-year bearer.

Nowadays the plant developer has this matter of every-year bearing in mind, and varieties of plums have been developed which conform to

this business principle. Our fathers pretty generally supposed that a fruit failure about every second or third season was to be expected. Now we know that the right variety of fruit can be depended on to give a crop each season.

In selecting stock for your prospective plum orchard, bear this point very carefully in mind, and choose only such varieties as have the inherent tendency to bear fruit with regularity.

Size and Quality of Fruit

It was just noted that a prune may be so large that it dries badly. This is not likely to be the case, however, if the prune ripens early and has a high sugar content. And as to plums in general, large size is, of course, a foremost merit.

There are other fruits that sometimes tend to grow too large. This is true of certain pears; also of some peaches. But the plum has not as yet been developed to anything like the maximum size, notwithstanding the very great improvement of recent years. A good many of my newer plums are giants in comparison with the standard plums of a generation ago. But no one complains that they are too large. On the contrary, their unusually high price in the market is due in considerable measure to their large size.

In selecting the ideal plum there is no reason nowadays why you should not secure one that bears fruit that is at least two inches in diameter on the average.

In form the plum should approach the globular. This is best in most fruits, for the reason that the spherical form is the most compact, and therefore the one best adapted to handling and packing.

The suture in the plum is a mark of recognition, but of no value to the fruit in any way. It is mostly due to the fact that one side of the plum grows slightly larger than the other. But this is a matter that concerns the pomologist rather than the fruit originator or grower.

The same is true of the ridge on the plum stone. It is a mark often used as a distinguishing character between different varieties, but which has no practical significance.

The plum should be of some attractive color, red, yellow, or even a brilliant white. Green fruit is never attractive. It would appear that the birds and man have combined forces to produce red and yellow fruits by selection, because these colors are enticing, and we have come to associate them with superior qualities of fruit.

The skin of the plum should be thick and firm, especially if the fruit is to be shipped to a distant market.

For home use or a near-by market a thin-skinned plum may be quite as satisfactory.

The bloom of the plum adds to its appearance, and its condition may be a test of freshness. The bloom evidently had originally a protective function, possibly shielding the fruit from the sun, or otherwise protecting the juices from too rapid chemical change.

The bloom may be developed on a fruit by means of selection where it is especially desired for any reason. It is obviously only a minor characteristic of the perfect plum.

The flesh of the plum should be firm, particularly if the fruit is to be used for shipping purposes. The texture may be shown by cutting the fruit with a dull knife. For home consumption, plums that are very watery are often considered a great treat. I have some splendid watery plums now growing—fruits that almost melt in the hand. But these have not the texture to stand the trip to market and keep in good condition.

The orchardist must bear this difference clearly in mind, and let the choice be determined by the use for which the fruit is intended.

Nearly white is usually the most suitable color for the flesh of the fruit. Yellow flesh is also admissible, and sometimes pink or crimson. The plums with crimson flesh, as we have elsewhere learned, are all descendants from the Satsuma plum which was one of my earliest importations from Japan.

Plums show almost every possible combination of flavors. Appearances are sometimes deceptive as to the eating qualities of the fruit.

As an instance, one plum that I have named the "Fraud" is extremely beautiful to look at, but its flavor is that of vinegar. There is, of course, a great range of variation between different plums — even aside from those that rank as prunes—in the matter of sugar content. Some are very sour and require a great amount of sugar when cooked; others require almost no sugar, except possibly to bring out their flavor.

Taste and aroma are so closely associated that they may be said to be almost identical. They simply represent the same thing as interpreted by different organs of sense. It is obviously desirable that a market fruit should have an attractive aroma, for both market man and customer often judge the fruit by this quite as much as by the taste.

Closely associated with the flavor of the plum is the matter of a chemical content that will resist fermentation. A fruit that is too juicy and does not contain enough sugar will ferment very easily, as we have seen in connection with our studies of the prune. Some plums are peculiarly subject to fermentation, particularly if bruised in any way.

Plums that contain plenty of sugar are, as we have seen, more resistant to fermentation.

This is one reason why prunes have gained in popularity for shipment in the fresh state to the eastern plum market. There is a good field for investigation as to the particular qualities, in addition to sugar content, that tend to make a fruit resist fermentation. In general it is observed that insipid fruits decay first.

Highly flavored acid fruits as well as very sweet ones tend to resist fermentation.

But the precise chemical conditions that have to do with this very important property of resistance to decay have been but little investigated. All that the prospective orchardist can do at present is to select varieties of fruit that have been shown to have good marketable qualities.

Finally, there is the matter of the stone. In the case of the very soft plum, the stone may serve

a useful function in giving support to the fruit. But the stone may be somewhat smaller than it commonly is and still give adequate support. In the development of stoneless plums it will be necessary to bear in mind that the removal of the stone to some extent takes from the fruit its natural support, and the plant developer will select with intent to increase the firmness of the pulp of the fruit.

Where the stone is retained it should be free, particularly in the case of the plum. The advantages of a freestone fruit are obvious to every fruit eater. Varieties of plums have been developed in which the stone becomes practically detached from the fruit on ripening.

There is now no reason why the orchardist should not include freestone among the qualities that he demands of his ideal plum.

If to these qualities of root and branch and leaf and flower and fruit we add the one comprehensive requisition that the texture of tree and fruit alike should have the indefinable quality that makes it resistant to disease, we have perhaps summarized in broad and general outlines the most essential qualities of the ideal plum.

It may properly enough be said that no plum hitherto developed can measure up to the maxi-

mum or ideal standard as to each and every one of these qualities. The production of a variety that will meet these requisitions remains for the plant improver of the future—perhaps of the not distant future.

Meanwhile it will, I think, be admitted by those best competent to judge that there are some of my hybrid plums, notably, for example, the Wickson, the Formosa, and the Santa Rosa plums, and the Sugar, Standard, and Conquest prunes, that, in their respective fields, make a fair approximation to the ideal standard. There are plums in the orchard that excel all these in some respects, but have not as yet all the qualities in combination.

Building an ideal plant of any kind is like building a house. Each must be planned in accordance with a clearly conceived idea. But there is this great difference: in the case of the plant you must wait for nature to supply you with the material with which to build.

NEW PLUMS AND PRUNES IN THE PROCESS OF MAKING

Some Suggestions on Which Others May Build

ON one occasion a well-known nurseryman who had bought a large number of fruit trees from me stopped before a tree in my orchard and tasted the fruit with the air of an expert.

"That's the best plum I ever tasted," he said, as he looked at the tree with admiring eyes. "At last you have a perfect plum. It has just the right amount of fruit on it; the taste is perfect! Sell me that tree and I will make a fortune from it."

"It's not for sale," I was compelled to answer.

Thinking I wanted a fancy price, he started to figure what he could pay.

I interrupted to tell him the faults of the fruit. It could not be shipped; it would not bear with any degree of certainty. He had chanced to see the tree on the very day in the year when it was

on exhibition at its best. We had had a week of cool weather and all the plums had ripened slowly together on the tree; they had responded to ideal weather—and produced a beautiful fruit of superior flavor. But conditions are not always ideal by any manner of means—and this plum could not stand adversity.

The next year the would-be purchaser saw the same tree—coming, in fact, for the further observation of it—and found the fruit worthless. For three days we had had unusually warm weather, and the fruit lacked quality. My estimate of it had been verified.

This is related to illustrate the need of caution in judging a new fruit. The work is not over when the plum is produced; the fruit must be tested under varying conditions and in successive seasons.

But, of course, there is no great difficulty in applying the final tests. That requires only patience and open-mindedness. The real difficulties were encountered at an earlier stage of the experiment.

What some of these difficulties are, and how they may be overcome, will be told in the succeeding pages. We have considered the ideal plum somewhat attentively from the standpoint of market man and consumer. Let us now regard

the same subject from the standpoint of the plant developer and orchardist.

The first step in plum improvement obviously involves propagation by seeds. In my own work great effort is made to secure seed of the best varieties at the outset.

As we have seen, seedlings from cultivated fruits always show a wide range of variation. Such variations offer opportunity for selection.

An Outline of Methods

The simplest method of working for improvement is to select the best seedlings thus obtained, without attempting pollenizing experiments.

An extension of the method calls for cross-fertilization within the species—followed again, of course, by selection.

A yet bolder method, and one calling for more time in the work of selection, may be used—that of hybridizing individuals of different species.

Finally the method may be so elaborated that several of the best varieties of different species are intercrossed to form new varieties. The plum "Combination," as an instance, combines the characteristics of three widely varying species and of numerous varieties within these species. Most of my recent plums carry the strains of many diverse species.

PURPLE-LEAVED PLUM WITH FRUIT

This is the so-called "Oval Crimson" variety of purple-leaved plum. It is a fruit of very attractive appearance and of good quality; which is by no means usual with the fruit of the purple-leaved plum. As a rule these plums are prized for their ornamental foliage rather than for their fruit. (Life size.)

This perfected method has been little used by other plant originators, but its practicability and value are demonstrated by the results.

The wide range of results attainable when these methods are used is shown by the fact that I now have plums the flavor of which is very similar to the following fruits: peach, apricot, apple, pear, lemon, orange, banana, pineapple, and berries of various kinds.

In addition to these, there are flavors that cannot be described because they are unique—due to new combinations or blends.

Although the flavor of a fruit is only one of its important attributes, it sometimes determines the value or lack of value of a new variety, and it is always an important factor. In many cases I have produced new varieties of plums which were good in every respect except the flavor, and because of this one defect they were destroyed.

Plums in my present colony are of every imaginable color and quality and ripen at all seasons from the earliest to the latest. Some trees have green foliage and some have purple. The trees also differ in growth in almost every imaginable way. Some are adapted to cold climates, some only to warm. Some require much moisture. Some will thrive under semi-arid conditions. A few give promise of being

adapted to such a variety of climates that—like the Burbank plum—they may be grown practically throughout all the plum-growing regions of the world.

And the explanation of this diversity is found in the wide range of ancestral strains that have been blended to produce this versatile company.

Europe, Asia, and America have furnished the foundation materials upon which have been built the seventy or more varieties of plums, prunes, and plumcots that have already been sent out from my experiment grounds since the first importation of Japan plums in 1885.

The Asiatic plums have been the most used, forty-three of the varieties introduced being developed from them.

Fourteen introductions were developed in part from American, and twelve in part from European species.

Native Raw Materials

The influence of foreign blood in our plum family has often been mentioned. Let us now give recognition to the contributions of the native stock.

The native plums of America, although usually of a good flavor, are not nearly as large as the Asiatic species, and not as large as the

American cultivated plums, and no larger than the wild ones from Europe.

But they possess the important characteristic of hardiness. For this reason, it has been necessary to use them in many cases to combine with more tender species in order that the new varieties might become standards in the colder sections of the United States and other countries.

Six important American species have been used in these experiments: They are known as the American plum (*Prunus americana*), the Wild-Goose plum (*P. hortulans*), the Chickasaw plum (*P. angustifolia*), the western Sand Cherry (*P. Besseyi*), the Beach plum (*P. maritima*), and the California wild plum (*P. subcordata*).

These were the native wild plums of the Middle, Eastern, and Western States and the Rocky Mountains south to the Gulf of Mexico. Most of them are unusually hardy. Cold does them no harm even in the northernmost part of the central division of the United States.

As to quality of fruit, these wild plums differ, but all the cultivated varieties have attractive flavors, and these flavors have been blended variously in no fewer than fourteen new varieties that I have thought worthy of introduction.

Anyone who has experienced the delightful flavor of my plums, Gold, Shiro, Geewhiz, Duarte, or America, will be interested to know that these new varieties (along with ten others) are American plums, reconstructed through combination with other species, but owe their flavor largely to their wild American ancestors.

To develop the earliest plum in existence from six species of later plums seems an impossibility. Yet this is what happened when the Wild-Goose type was combined with five other late-ripening species. The plum introduced from this complex combination has been aptly named "First." It was the *first* introduced variety in the making of which the Wild-Goose had a part, and the *first* plum to ripen of all those grown in California at the time of its introduction in 1901.

If the Wild-Goose plum is mentioned, the Chickasaw should not be overlooked; for although it has not served in the production of any introduced varieties, its hardiness has contributed valuable attributes to many varieties still in the proving orchard.

But perhaps the greatest interest attaches to the story of the little Beach plum. In its wild state this is not much sought; for its fruit varies

from the size of a large pea to that of a small hazelnut, and it is inedible unless cooked. Yet this little plum has some flavor; it makes jams and preserves of good quality.

The results produced on my grounds with this species are so important as to indicate that the Beach plum is highly valuable to use in the development of new plums for cold climates. I have produced four important varieties in which it is one of the parents.

The story of these ennobled Beach plums is so interesting and suggestive that it is worth telling somewhat in detail.

The Ennoblement of the Beach Plum

Perhaps the most astonishing result produced by hybridizing the little Beach plum is the fruit to which I have given the provisional name Giant Maritima.

This is a second-generation hybrid from an improved hardy Beach plum pollenized with one of the hybrid Japan plums.

In 1895, the first year this seedling bore, the fruit was one hundred times larger than its seed parent, the *maritima*. In 1896, the fruit was even larger than in the previous year, and in 1899, as the tree gained in age and strength, the size was still further increased.

In that year some of the fruits were measured and found to be eight and a quarter inches in circumference.

The Beach plum from which this remarkable hybrid was developed is a native of the Atlantic coast of North America, growing on the sands and among rocks near the seashore from Labrador to North Carolina. It is known botanically as *Prunus maritima.*

It is one of the hardiest and toughest of all known wild plums. It is a low, compact bush, rather than a tree, with rough, even thorny, branches, and small dull green oval leaves. The flowers are small, but are produced in great profusion, making it almost worthy as an ornamental plant. The fruits, as before stated, are small, usually less than half an inch in diameter; and they are quite commonly bitter, being almost or wholly inedible unless cooked.

The Beach plum for many years has been known to possess some horticultural possibilities, especially hardiness, productiveness, and general "staying" qualities under the most trying conditions. The value of these characteristics was discovered soon after my general plum experiments were started, and every effort was made to cross it with some of the larger and finer species. For several years this cross could not be effected,

mostly because the Beach plum blossoms very late, long after all other plums have shed their bloom.

Finally, however, very late blossoms of the latest plums of other species were cross-fertilized with some of the earliest Beach plum blossoms, the crosses being made both ways.

In the meantime I had been growing seedlings of the Beach plum by the hundred thousand. By continuous selection I had produced varieties bearing fruits nearly an inch in diameter, of a pleasing form and color, of delicious flavor. The trees, moreover, had almost incredible productiveness together with increased size and vigor.

Although my most enthusiastic friends often laughed at these extensive experiments with what they called my "huckleberry plum," and some of the best fruitgrowers made sport of the insignificant fruit, I saw in the little Beach plum great hardiness, late blooming, enormous productiveness, and the ability to withstand adverse conditions, and was sure of some measure of success.

Several crosses were finally made between the improved *maritima* and the best cultivated varieties of other American and Japanese hybrid plums. No really good fruits were obtained in the first generation, but some excellent varie-

ties, both in productiveness and quality, were produced in the second, third, and fourth generations.

Usually the first-generation hybrid *maritimas* make a much stronger growth than their wild parents, sometimes attaining four to six feet in two years, while the wild Beach plum on a good soil rarely grows more than three to three and one-half feet high in the same time.

The wild tree has short branches, black bark, and small leaves. The first generation hybrids of these with the American and Japanese plums have longer, smoother, and larger leaves, lighter colored wood, and longer and more slender branches.

These hybrid seedlings are easily distinguished the first season, as the Beach plum has red roots, while those of the hybrid vary, most of them being lighter. Beach plum seedlings, no matter how young, from seeds crossed with other varieties, show various shades between the pale yellow or brown root of the European and Asiatic varieties and the red root of the wildling, and if there were no other test this would be amply sufficient to prove them hybrids.

Such, then, was the parentage of the Giant Maritima, which first bore fruit, as already noted, in 1905—fruit over two inches in length. When

I first came across this enormous fruit on a tree with the Beach plum foliage and blooming habits, the branches literally hanging in ropes of gigantic fruits, I could hardly believe my own eyes.

The fruit begins to ripen here early in July, and when ripe it is a deep crimson, covered with a thin pale bloom. The flesh until fully ripe is very firm and solid, but it breaks down quickly when ripe. It is honey-yellow, with a pale greenish tinge. The quality is good. The fruit is fragrant, and as large as the Kelsey, Wickson, Climax, or any other plum known in 1905.

It is found necessary to thin the green fruit carefully, otherwise the tree would be crushed with its weight of fruit. It has been grafted into numerous older trees, and appears to be a strong grower. Having originated from such an unusually hardy wild stock on one side, it will no doubt produce a crop of fruit almost anywhere. In itself, however, this will never prove of much commercial value, as it lacks firmness of texture.

The Beach Plum in Other Combinations

The wild Beach plum was also crossed with my Combination plum, which has in its ancestry plums of almost every type. The resulting seedlings were not as good as had been anticipated, but two were very much liked by a well-known

GLOBE PLUM FRUITS

It will be seen that the flesh and the skin of this plum are almost uniform in color. This is a very unusual characteristic. The plum is a complex hybrid, and the red flesh betokens a Satsuma ancestor. Although named, this plum has not as yet been introduced.

California fruit grower, and were sold to him in 1908.

One of these was given the name "East." It is a prolific variety. The fruits are globular, pale yellow, half covered with a crimson bloom and numerous indistinct dots. The flesh, pearly yellow in color, is of good quality, though probably inferior to some of the best Japanese hybrid plums. The fruit ripens here from August first to fifteenth.

This was tried at San José for several years, but found to be too soft for shipping. It is, however, a desirable variety for home consumption. It has never been offered to the public.

The other plum from this cross is known as "Pride." It also proved to be of little value as a shipping plum. It ripens too quickly, so that it will not stand shipping any great distance.

Pride is apple-shaped, which is usually a desirable form. It is a good grower, an excellent bearer, and ripens about July 20th. The skin of the fruit is a deep red with a whitish bloom. The flesh is a dark red—showing a Satsuma cross—and of excellent quality.

Besides these, nearly two thousand other promising *maritima* hybrids are now being grown from these crosses. Many of them are

excellent in habit, productiveness, and hardiness. As yet only one of them has been sufficiently tested to warrant their introduction.

Tribute from the Sand Cherry

Another native American plum which is as hardy as the Beach plum is *Prunus Besseyi,* commonly known as the western Sand Cherry. Although it is called a cherry, it is really a plum and has been successfully crossed with the plums, as pointed out in an earlier chapter. It is thoroughly hardy in the Central and Northern States and is found most often in Minnesota and the Dakotas.

My work with this variety has not been so extensive as with the Beach plum, but has resulted in the development of one new plum which has been thought worthy of introduction. It was offered in my catalogue of 1911-1912 under the name Epoch, and is described there as follows:

"'Epoch' should be one of the hardiest of all known plums, as it is a cross of the western Sand Cherry and the American plum, both being about as near 'Arctic' plums as can be mentioned.

"The tree is a compact grower, dwarf, with dark brown wood, which always, without fail, produces ropes of fruit, each fruit one and a half

inch in diameter, beautiful crimson, with shades and dots of yellow. Flesh pure deep yellow, firm, with a rich cranberry flavor, but sweeter, and when ripe very good. Ripens August 15. The youngest, as well as the oldest, trees literally cover themselves with fruit, which keeps remarkably. Probably the most productive and best of all the 'Iron Clad,' *extremely hardy* dwarf plums."

As this variety has not been introduced long enough to get reports from growers in various parts of the country, it is not possible to say just how valuable it will prove to be. Its hardiness, however, is well established, for it has been grown in North Dakota, where the young trees have endured a temperature which no other plum had been able to live through.

This work of developing hardy fruits for the colder sections is being pushed by other workers. Professor N. E. Hansen, of the South Dakota Experiment Station, has been working for many years, especially in crossing the Sand Cherry with some of my best hybrid plums and with other varieties. He has been successful in producing several good hardy varieties.

It is to be hoped that others will enter into this work, as hardy plums are much needed in many northern regions of our country.

The California Wild Plum

Almost every imaginable flavor is to be found among the California wild plums (*P. subcordata*). Some are quite sweet, some are sour, others are distinctly bitter. A few are delicious. The fruit usually is small and round, about the size of the wild plums of the Mississippi Valley; and of brilliant red color, or sometimes yellow, and rarely purple.

Strange as it may seem, the best fruit is produced abundantly where the trees are growing on rather poor, almost desert soil.

The trees in different localities (and the same is true in a measure of each tree in the same locality) seem to have an individuality of their own, a somewhat characteristic condition with our California wild trees and shrubs. Some of these plum trees grow large and tall, with a straight, upright habit. Others form spreading bushes of low, compact growth that often bear abundantly when only a foot or two high, bending to the ground with their burden of fruit.

Under cultivation this plum has improved, and some selected seedling varieties are of very superior quality. Some of these plums when cooked have a flavor closely similar to that of the

best cranberries, which they resemble also in color.

When crossed with the Japanese, American, and European plums, a large and handsome fruit is developed, the form being usually nearly globular, but sometimes oval. The trees of these crosses are also greatly improved over the wild ones in form, size, and symmetry of growth. They are always hardy and vigorous, and are as a rule exceptionally prolific.

For jellies and canning these hybrid fruits are probably superior to any other class of plums, and a few of them are most excellent when eaten uncooked. In particular one which I have recently distributed under the name "Nixie" is valuable for use in any form.

The California wild plum has also had an important part in the production of the new varieties known as Combination, East, and Glow, all plums which exhibit the superior quality of the wild parent.

Thus have the native plums of the United States been used in producing new varieties.

The European species, though used to a slightly less extent, have produced results of even wider value.

The early settlers—either because they did not expect to find plums in America, or because

FIRM SWEET PLUM FRUITS

The surface dotting of the American varieties and the shape of the Japanese plums are shown in this attractive fruit, which is a complicated hybrid, the result of repeated crossing and selection. The native plums of America have had an important share in producing some of my most prized varieties.

they were attached to their own varieties—brought plums from Europe, known botanically as *Prunus domestica.*

The plums, like the settlers who brought them, found the adopted country hospitable. They thrived and multiplied. Seeds sprang into new varieties in the fence corners and some of them bore better fruit than the colonists had seen in Europe.

It was natural that these new varieties should spread while the less valuable ones were neglected. When a farmer journeyed from Plymouth to the home of a friend near Boston and saw there a plum better than the one he had brought from Europe, he secured grafts and gave the better variety the preference on his own farm.

Thus by the exchange of grafting wood, new varieties of plums were distributed among the pioneer farmers of the new land.

The Share of Europe

To-day there are at least a hundred improved varieties of the European type of plum, all of which, up to the last few years, originated from chance seedlings in the gardens of the first settlers. Among the best of these are the Washington and the Jefferson, both superior varieties.

It appears that some at least of the European plums originated in southwestern Asia. At all events, a plum that is thought to represent the original wild form has been found growing in the region about the Caucasus Mountains and the Caspian Sea.

It is known that the plum was one of the fruits and the dried prune a staple food of the Huns, Turks, Mongols, and Tartars, who maintained in this region a crude horticulture from a very early period. Here, even at the present time, plums are commonly grown and prunes are an article of trade.

The European plums have many unusually good qualities, including strong, vigorous, productive, hardy, upright trees with strong wood and branches capable of carrying heavy loads of fruit. Furthermore, they are not much subject to disease.

The fruit is not used so much for shipping long distances when fresh as some of my new Japanese hybrid plums. Some of the newer seedlings, however, such as the Splendor, Giant, Sugar, and Standard bear fruit which is shipped fresh in large quantities from California to New York and by sea to foreign countries every season.

For the most part the consumers of the large cities do not know that the big, sweet, luscious

plums that they purchase in June and July are of the same varieties sold in the dried state as prunes.

The European plums have been used in the production of eight of my introduced prunes and have contributed to these the characters necessary for drying and shipping.

The European plums produce new forms readily from seed, so that it is scarcely necessary to cross them with other species to obtain seedlings with rather distinct new characters. Furthermore, it is difficult to make productive varieties when crossed with other species. My experience has been that they do not cross readily with the Asiatic plums, *Prunus triflora, Prunus Simonii,* and *Prunus tomentosa,* nor very readily with any of the native American plums.

On the other hand, the common European plum crosses readily with the French species, *Prunus cerasifera,* the Cherry plum or myrobalan, often producing most valuable new varieties.

This French Cherry plum is a small, slender tree. It is usually quite productive, but no seedlings of large size or superior quality have ever been produced directly from it, and the fruit of its seedlings are not only lacking in quality but in size and firmness of flesh.

The only variety I have introduced which is a seedling of this plum is a cross with the Asiatic *Prunus triflora.* This hybrid is called Doris. There is blood of the French Cherry plum, however, in some hybrid plums, including my well-known Shiro and a few others.

The European plums have also contributed largely to the production of new races of fruit trees that are highly ornamental. A whole race of plum trees beautiful enough for lawn decoration has sprung into being in my open-air laboratory.

The French plum with purple leaves, *Prunus Pissardi,* formed the basis for the development of these ornamental fruit trees. The methods used in developing these hybrids are the same as with the others, and results are similar, although the fruits have not proven so generally valuable as certain varieties raised solely for fruit.

The main use of the purple-leaved plum is for decorative purposes, but the fruits of the two varieties introduced are good enough for home use and in some cases are sold in near-by markets. This refers more especially to the very early purple-leaved plums, the Vesuvius, Othello, and Thundercloud.

The story of the stoneless plums, which also owe their origin to European stock, has been told elsewhere and need not be repeated here.

The unique form of the Apple plum, the delightful Bartlett pear flavor of the Bartlett plum, the appetizing color of the Santa Rosa, and the large size and remarkable shipping qualities of the Wickson would not have been developed had it not been for the use of the Japanese species, *Prunus triflora.*

TRIBUTE FROM THE ORIENT

Indeed, the Japanese plum stands as part contributor to forty-three varieties added to American horticulture. These have been sent out from my farms, and few nursery catalogues list more than two or three Japanese plums other than these varieties, although several have been developed by other workers.

China, as well as Japan, has furnished material for the development of highly valuable plums. The well-known varieties, Maynard, Climax, Chalco, Santa Rosa, and Formosa, and many other newer seedlings, have in their make-up the blood of *Prunus Simonii,* the apricot-plum of China.

This fruit takes its name from Eugene Simon, who introduced it into France from China in 1872. It was distributed in this country about 1881. It is peculiar in shape, being a large, flat, tomato-shaped plum, with dark orange-brown,

THE APPLE PLUM

It is difficult for the casual observer to believe at first that the plum here represented is not an apple, as it has the form, color, general appearance, and rare keeping qualities of the fruit that suggested its name. It is a remarkably free grower, having led to the comment that buds and grafts of this variety "would probably grow if fired among the trees from a shot-gun."

hard flesh, purplish-red skin, and a small stone.

The fruit is sometimes eatable, and sometimes classed as good when grown in the hot, dry climates of the interior valleys of California. Its merits and defects were outlined in an earlier chapter. Here I will only add that it is by no means necessary to have a perfect fruit to begin your experiment. I have in many cases developed the very best of new fruits from two nearly worthless ones.

In selecting the Simon plum for these experiments, its value for plant improvement was considered and not its value as a market plum.

As a result of its use, its small stone, delightful aroma, and desirable tree characters have been imparted to a new race of plums, several of which have already added millions of crates a year to the shipments of the principal plum-growing sections.

Others even more promising are still in the test orchard awaiting final approval.

Such, then, are the materials that have been utilized in the development of new fruits. The native plums of the Middle West, the worthless wild plums of the bleak coast of Labrador, the plums of the Pacific slope; those which our forefathers brought from Europe; a worthless, wild,

half-stoneless plum; plums from Japan, some with red flesh; other Japanese and Korean varieties with large bright-colored fruits and delightful flavors; the apricot-plum from China, the purple-leaved plum from France and the *cerasifera,* which has been grown mostly for grafting stocks, have all been freely used.

Although some of these species are insignificant in themselves, their characters by combination and careful selection have had a share in making fruits of the rarest and most desirable qualities.

And the work, notwithstanding its notable results, is only at its beginning.

The Mystery of the Bud

In completing this outline of the methods of plum development, let us now consider a little more in detail an aspect of heredity which concerns equally all our other cultivated orchard fruits, and which must seem mysterious to everyone who gives the subject a moment's consideration. I refer to the familiar but extraordinary fact that whereas the bud or cion of a given tree will reproduce the fruiting qualities of the parent with the utmost fidelity, yet the seedlings grown from the fruit may have the widest diversity.

It has been pointed out that you need not hybridize the orchard fruits in order to get new varieties. The seed of almost any plum tree, for example, will give you seedlings aplenty that are different from the parent tree.

That a single variety may thus contain the potentialities of a hundred different types of future fruit is a mystery to which we have referred, but to which we may recur without apology.

When we further reflect that the branch in question, which carries this amazing heritage, perhaps grew from a single pea-sized bud inserted on the trunk a few seasons ago; and that the tiny bud in question must have contained, predetermined within its apparently insignificant substance, all the potentialities that will be revealed in all the different "varieties" of its progeny, the mystery becomes still deeper—if comparison be permitted between the various aspects of a subject every phase of which lies almost beyond the bounds of human comprehension.

But even though we cannot hope fully to understand, much less to explain, the mysteries of heredity of which the case of the bud furnishes a familiar yet striking example, we can not help pondering on the matter. And nowa-

days we are accustomed to associate function with structure everywhere in nature, seeking a physical basis for the observed phenomena associated with life processes, it is natural that here as elsewhere attempts have been made to visualize the conditions that obtain in the germ plasm of the plant, and to picture in imagination its actual mechanism.

In our age the telescope, fortified by the weirdly penetrative spectroscope and aided by the most sensitive photographic plate, has enabled the astronomer to reach out into unthinkable realms and to record not merely the direction and speed of light, but even the chemical composition of stars so distant that their light, traveling 186,000 miles per second, requires ages to reach the earth.

With the aid of the same instrument, the universe is proved to be peopled with dark stars, definitely revealed to us even though forever invisible; the structure of the universe as a whole is coming to be understood, and the course and direction and speed of groups and streams of stars by millions have been tested and charted.

In such an age it is not strange if the worker who turns his eyes in the opposite direction, and attempts to penetrate the mysteries of the micro-

cosm of the plant or animal cell should have found means to pass beyond the range of vision of the microscope and reveal something of the intimate nature of the events that are taking place in the world of molecule and atom and electric particle.

Aid from the Microscope

In point of fact the invasion of the world of the infinitely little by the modern biologist has been no less wonderful than the exploration of the world of the infinite vastness by the astronomer.

And perhaps it should not seem strange to anyone who has a philosophical conception of the underlying harmonies in nature, that the conditions revealed in the microcosm of the living cell should suggest in many ways an epitome of those made manifest in the macrocosm.

Such, at all events, is the message that the modern biologist and physicist bring us from the world of infinite littleness. Making the first stages of their invasion with the aid of a microscope, they show us that all living tissues, vegetable or animal, are composed of cells, and that within each cell there is a vitally important central structure called the nucleus.

This structure lies at the heart of every germ cell through which a living organism propagates its kind.

The pollen grain of the plant, for example, is the carrier of such a germinal nucleus. The pollen grain itself is a structure of almost microscopic size, yet it is colossal in comparison with the infinitesimal fleck of germinal matter that lies at its center. Yet the modern microscope can so magnify this fleck of matter that something of the mechanism of its vital parts becomes visible.

The microscopist tells us that within the germinal nucleus there are to be seen sundry films of matter, arranged to form a sort of skeleton, which are readily stained under his manipulation and which he therefore names "*chromosomes*," colored bodies. He observes that the nuclei in cells of different plants and animals have these infinitesimal chromosomes arranged in different characteristic groups, differing in number in different species, but always the same for each and every cell of plants or animals of a given species.

The enlarged vision of the microscopist enables him to assure us that when two germ cells of the opposite order come together—when, for example, the nucleus of a pollen grain blends

with the nucleus of the plant ovule—there are various characteristic dividings and interlinkings between the two sets of chromosomes within the two nuclei.

In the blending and rearrangement of these minute structures, he believes that he is witnessing the underlying processes that bespeak the blending of hereditary potentialities and their recombination to determine the future possibilities of the new organism that is thus brought into being.

All this is very wonderful. But it brings us after all only one stage nearer the confines of the mystery. The chromosomes within the nucleus, which all biologists nowadays regard as the tangible carriers of hereditary tendencies or capacities, are few in number, and, small as they are, we are forced to conclude that each of them must be the carrier, not of a single potential trait or tendency, but of a multitude of such potential traits or tendencies.

Our practical experiments in plant breeding have shown us that we deal often with a dozen or more tangible characters that are grouped against each other in opposing pairs—definitive qualities of size or color or flavor of fruit and all the rest—and it requires but a moment's thought to see that each of these "unit charac-

ANOTHER VIEW OF THE APPLE PLUM

In noting the very peculiar apple-like character of this fruit, it is interesting, by way of comparison and contrast, to consult the earlier pictures showing the wide variation of plum forms, including the inverted pear shape, the even oval of the Splendor prune, and the almost spherical form of other types. (*Life size.*)

ters" is in reality made up of a multitude of minor characters.

Heredity carries all of these definitely from one generation to another; so their potentialities must be represented within the structure of the chromosomes; and there are by no means chromosomes enough to supply one for each hereditary character.

So we are obliged to assume that each chromosome is in itself a complex structure, and that within that structure there are subordinate structures—like the individual bricks and boards and nails and rivets that go to make the structure of any piece of human architecture—that determine by their quality or their arrangement the specific potentialities of the future organism. Each chromosome, in other words, must be thought of not as the tangible conveyer of any particular "unit character," but as a receptacle in which several or many factors or determiners of diverse unit characters—size of flower and color quality of leaf and fruit and all the rest—are assembled.

Further Aid from the Physicist

But unfortunately the powers of the microscope do not suffice to reveal these unit structures within the chromosome.

What they are like must for the present remain only a matter of conjecture.

But that they are definite mechanical structures of unthinkable smallness, represented by chemical atoms in specific combinations, we cannot doubt. And in revealing to us the size and character of these atoms, the modern physicist gives us aid in supplementing the vision of the microscopist and in helping to make it seem at least a possibility that the definite factors of heredity have a physical basis within the microscopic chromosomes.

The conclusions that give this assurance are based on various almost infinitely delicate tests that are made in the modern physical laboratory.

Summarizing these in a few words, it appears that the physicist and chemist are now able to make definite computations as to the size of the molecules and atoms that make up the structure of all matter. And the figures they present, when they have taken a census of the atom, are such as to give us full assurance that even so small a structure as the minutest chromosome within the nucleus of a plant cell contains molecules and atoms in such numbers as to make possible an infinite complexity of arrangements and therefore an infinite diversity of resulting qualities.

Thus we are told that the smallest particle of matter visible under the magnifying influence of the most powerful microscope is of such dimensions that 50,000 of such particles placed in line would be required to cross the space of one centimeter or about two-fifths of an inch. If we calculate the cube of this number we find that 125 thousand billion such particles could be crowded into the space of a cubic centimeter. But it further appears that, according to a definite measurement made by Professor Rutherford, more than 20 billion times that number of helium atoms would exist in the form of gas in the same space.

And the commentator I am quoting adds: "Of course the molecules of gas are widely separated. So it follows that the smallest particle of solid matter visible through the most powerful microscope contains many times 20 billion atoms."

"Many times 20 billion atoms" in the smallest particle of matter that the microscope reveals! Vastly more than that number of atoms, then, in each individual chromosome of the group lying within the nuclei of pollen grain and ovule —since these are by no means at the limits of visibility. And each atom has itself specific individuality. Each group of a thousand atoms

or so might make up a molecule of a different type of protoplasm.

So here is material for millions of kinds of protoplasm, were so many needed.

Here within the infinitesimal germ cell, revealed to us in part by the microscope of the biologist and for the rest made manifest in imagination by the revelations of the physicist, is material enough to supply tangible carriers for all the conceivable hereditary factors that come to make up the most complex organism of any plant, or for that matter of any animate creature whatever.

The Germ Cell a Complex Organism

Let us make the illustration specific. Suppose that the chromosome in the nucleus of any given pollen grain—say that of a plum blossom—were of the very smallest size visible under the microscope. Suppose, also, merely for the sake of illustration, that the hereditary factors for unit characters that it bears are of a thousand different types—representing all details of size and color and foliage and growth and leaf and blossom and fruit of the future tree. We know that the chromosome really does bear these potentialities; I am merely assuming their number at a thousand individual units for illustration.

In our former views, when we considered the transmission of complex qualities by the infinitesimal pollen grain the thing seemed utterly inscrutable and mysterious. But now, with the aid of the new facts that the physicist has supplied us, the mystery is somewhat clarified. He shows that the smallest visible bit of protoplasm must contain at least twenty billion atoms.

So there would be enough of these atoms to supply no fewer than twenty million to make up the structure of each individual hereditary factor.

Now twenty million bricks, of ordinary size, piled solidly together, would make a mass 100 feet square and 300 feet high.

So the structure of each hereditary factor of all the thousand in our infinitesimal speck of germ plasm may be as complex as any building that could be made with such a pile of bricks as that—and more complex, no doubt.

Add that each individual atom in our germ plasm structure is no crude brick, but is conceived by the best informed students of physical science to be "at least as complex as a piano," and we gain a yet clearer conception of the possible intricacies of the mechanism of each of our imagined thousand hereditary factors.

In this view, then, the germ cell may well be an organism as complex and of as definite a system of architecture as the full grown tree into which it will ultimately develop.

The leaves of a tree—even the leaves of a forest—are a meager company compared with the census of the atoms within the nucleus of a single germ cell.

An Amazing Microcosm

Nor need we limit our view to the germ cell that produces a single plant. Let us consider for a moment the bud from which the branch grew on which are produced, according to our illustration, plums, the seeds of which may give rise to some hundreds of different "varieties" of fruit.

Do the analyses of miscroscopist and physicist make comprehensible the fact that the original bud of the plum tree can contain potentialities of so many different complex structures?

Another glance at the figures of the physicist will supply the answer that would have been bewildering were it not for what we have just seen as to the complexity of the germ plasm. It appears that, according to the estimates of Professor Rutherford (based on accurate count of the atoms given out as so-called alpha particles in

the radiation of radium) the mass of an atom is so inconceivably small that the number of atoms making up a portion of matter as big as our plum bud (which we may assume to have the bulk of about a cubic centimeter) is represented by the figures 68 followed by twenty-four ciphers—68 "octillions," if the figures must be read.

So the number of atoms that are aggregated in the tiny plum bud is vastly greater than the total number of people that have lived on the earth since the human race was evolved.

To attempt to give tangibility to the idea of the smallness of the atom, we may borrow an estimate made by the late Lord Kelvin. It may be computed that if the tiny plum bud were imagined to be enlarged in size until it became as big as the earth, each component atom being increased in the same proportion, its entire structure would then be made up of units (magnified atoms) of about the size of footballs.

If we then reflect, further, that according to the definite analyses of other physicists, with Sir J. J. Thomson of Cambridge at their head, each atom is itself a complex structure—the very simplest atom, that of hydrogen, being composed of at least 1,700 particles called electrons which are in reality the unit particles of electricity—we

A SEEDLING CRIMSON-LEAVED PLUM

One of the most striking of plum seedlings, being the result of Kelsey, *cerasifera, triflora, and apricot cross.* T*he magnificent reds of leaves and fruit make a strikingly handsome and effective combination that is as pleasing as it is unusual.* T*his has been named "Vesuvius."* (*Natural size.*)

shall gain a still more enlightening view of the complexity of our plum-bud microcosm.

It has been estimated by a French physicist, Becquerel, that the size of the individual electrons that make up the atom is such that they may be thought of, not as piled solidly together within the structure of the atom, but rather as infinitely separated by comparison, like a swarm of gnats flying about in the dome of a cathedral.

It is a little difficult for anyone not accustomed to this particular use of the imagination to follow the conceptions of the physicist. But we may accept his findings as authoritative, for they are the result not of one man's work alone but of tests that have been applied by many workers.

Making the application to our plum bud, then, it appears that its bulk is such as to give us assurance that it contains (although it actually is no larger than the smallest pea) a number of atoms so great that if the atoms were conceived to be all gathered into 8,000 different groups (each group representing a different variety of future plum), there is material enough to supply at least eight million billion atoms in each group! And each of these atoms is itself a complex structure made up of several thousand electric corpuscles.

Now we know that each particle of protoplasm, the physical basis of all life, is composed of atoms of carbon, hydrogen, nitrogen, and oxygen in complex combinations. A single molecule of protoplasm may contain a thousand or more atoms.

But even allowing a thousand atoms to each molecule, we have ample material for the construction of something like eight million billion molecules for each one of our 8,000 groups of potential plum trees.

Obviously there is abundant opportunity for the combination of such material into complex groups, quite adequate to account for the different qualities of our various plums—be they ever so divergent as to form or size or color or flavor.

The Bud as a Walled City

In this expanded view, then, it is no more wonderful that a pea-sized plum bud can obtain within its germ plasm the potentialities of hundreds of varieties of future plums than that a city can comprise hundreds of houses, no two just alike, all built of wood, brick, stone, and metal in different proportions and combinations; just as the germ cells are all built of the atoms of carbon, hydrogen, nitrogen, and oxygen in different combinations.

There are far more bricks (atoms) available to build each different type of germ plasm in our plum bud colony than are required to build the largest structure in the man-made city.

The real wonder, as I said before, lies in the fact that each infinitesimal aggregation of molecules of protoplasm has the capacity to take to itself stray atoms that are brought into its neighborhood, shape them into its own structure, somewhat as a bricklayer shapes the bricks into the walls of a building, and thus increase constantly in size.

It is this capacity of the germ plasm to gather material and utilize it in expanding its structure—together with the further capacity to move in response to environing forces—that is the underlying mystery of the entire life process, including the interesting aspects of it that we see manifested through heredity.

In a word, a fruit bud is a walled city tenanted with a multitude of complex structures, and the mere size of the bud, in our clarified view, has nothing whatever to do with the wonder of its composite architecture.

The phenomena of the germ cell have hitherto appeared peculiarly mysterious simply because our blunt human senses deal ordinarily with masses of matter of a more tangible size.

Now that the microscopist and the physicist have opened the way for us into the microcosm, we see that mere size is of no great significance in the matter, and that there is ample opportunity within the nucleus of the smallest germ cell for an organization of molecules and atoms that for all practical purposes may be at once as complex and as definite as the visible structure of the mature plant in which the germ cell sprang or of that other mature plant into which it will develop.

The work, notwithstanding its notable results, is only at its beginning.

WHAT THE BURBANK PLUMS AND PRUNES HAVE EARNED

The Opportunity Which Improvement Opens Up

THE BURBANK plums and prunes have earned money for everyone except the originator. Introducers, growers, canners, and shippers, transportation companies, dealers, and consumers have made and saved money from these fruits.

The originator, on the other hand, as nearly as he can estimate, has received about 50 cents on each dollar invested in the work of plum development.

My experiments altogether—nearly one-fifth of which have been devoted to plums and prunes—have cost me very nearly $250,000. The income from the sale of new varieties has been approximately $100,000. Up to 1912 I was about $150,000 behind on all my experiments. But the loss on the plums has been less, probably, than

that on a good many other lines of experiment, and there is reason to believe that varieties not yet introduced will presently bring a return that will more nearly balance the account; but from my books, lectures, and other sources I have at last, by good business management, now made the account balance well on the right side.

Meantime, the sums earned for others by the Burbank plums and prunes after they have gone out into the world have been really significant, from whatever standpoint considered.

As illustrating their earnings in a single field, we may note that in the season of 1912 there were 564 carloads of Burbank plums of different varieties, aggregating 396,133 crates, shipped from California alone to the eastern markets. This represented more than one-third of all the shipments of plums. The average price per crate received for all Burbank plums was $1.20 as against $1.03 the reported average for other varieties. The maximum price per crate for any Burbank plum was $3.25 as against a maximum of $3.04 for any other variety; the highest average prices per crate being respectively $1.71. Millions of crates are now (1920) shipped, and prices have ranged from $2 to $4 per crate this season.

The total wholesale price of the Burbank varieties of plums shipped in this single season was not far from one million dollars.

If individual varieties are under consideration, the plum specifically known as the Burbank excels any other single variety by a large margin; the figures being, for the season of 1912, for the Burbank 116,764 crates, and for its closest competitor 98,149, a difference in favor of the Burbank of 18,615 crates. Some of my other new plums take the lead.

If prices are taken into account, the lead of the Burbank becomes still more significant, the highest price per crate for this plum being \$1.93, and its average price \$1.12. The total revenue from shipments of this single variety of plum was more than \$130,000 in 1912.

And all this, of course, refers to the Burbank plums merely as shipping plums from a *single district*. It takes no account of prunes, the handling of which constitutes an altogether independent industry. Nor does it, of course, refer in any way to the shipment of plums from any region except California. Yet the Burbank plums are grown everywhere, and in some remote regions as, for example, South Africa, they are raised on the largest commercial scale. The bushmen of Australia are perhaps as familiar

AN EXAMPLE OF UNIFORM RIPENING

The Red Ball plum shown here approaches the ideal for extra early home and market purposes, which requires that the plum not only ripen evenly throughout its flesh, but that the individual fruits ripen simultaneously. With such a fruit the entire crop may be gathered at once — an obvious advantage to the shipper. (About three-fourths natural size.)

with the deep yellow, juicy, tender but firm flesh, and the sweet aromatic flavor of these plums as are the orchardists of California. They are equally well known in New Zealand, in England in France, in Nova Scotia, and in southern Canada, and in this country they have become the standard in all the States except Wyoming.

The total number of nurserymen in America who list Japanese plums is 150, and of these 142 list the Burbank; a record not approached by any other plum.

A More Comprehensive Valuation

But these figures, and any others of like character that might be collated, serve, after all, to give only a vague and general idea of the economic importance of the new plums.

Statistics having to do with shipments to the great markets, even were they available for all territories, would tell but a small part of the story. The true benefits accruing from this work cannot be reduced entirely to figures.

A large proportion of the earnings, for example, have been protective—in the nature of assuring large and regular yields of superior quality; thus giving significant returns each year instead of uncertain yields occasionally.

Again, even the most elaborate statistics would entirely fail to present the facts at their true value, because the identity of a plum is often lost through the prevalent custom of renaming varieties. The Abundance plum, as an instance, has been designated "Botan," "Botankio," "Chase," "Yellow Japan," "Douglas," "Oval," and probably by other names by the growers and sometimes also by the nurserymen and dealers. The Wickson plum has been sold under the name "Eureka," and similar liberties have been taken to a greater or less extent with each of the twenty Burbank varieties that are prominent as shipping plums.

Therefore the figures based on the records of distribution, growth, and sale of a variety are sure to be far below the correct figure.

But most important of all is the fact that a large part of the entire plum crop is grown for home consumption or for distribution in local markets or shipped by sea, of which no record is available. With the wide distribution of Burbank products over the entire world, in many cases in countries where no systematic public records are kept, there are unrecorded benefits, profits, and earnings to the extent of millions of dollars annually, of which no accurate estimate can be made.

And, finally, even if complete up-to-date records of the earnings of the Burbank plums could be collated, the figures would give but a vague idea of the real importance, from a purely economic standpoint, of the work that has been accomplished, for the reason that it takes a long time to introduce a new fruit, whatever its importance, and the best Burbank plums and prunes have been developed within very recent years. Of my quartette of "best" plums, only the Wickson has been on the market long enough to acquire anything like the reputation and the vogue that its merits justify. As to the others, Formosa was introduced in 1906, Santa Rosa in 1907, and Beauty, perhaps the best of all, only in 1911.

So whereas we find that the Wickson was shipped from California in 1912 to the extent of one hundred carloads, there were only two carloads of Formosa and fourteen carloads of Santa Rosa recorded, and of course Beauty is not represented at all.

Obviously, then, the earning power of these newest and best plums is a matter for the future. When the statistics are collated, let us say for the year 1925, it will be possible to gain a clearer view of the real importance of these new productions.

Of course, orchardists are proverbially conservative. Perhaps it is natural that they should be so, considering that they deal with trees that require some years to come into bearing. An orchard cannot be made in a season, like a grain field, but the rapid conquest effected by the Burbank plum and others of my earlier production leaves little room for doubt that my newest plums will make their way no less effectively in the course of the coming decade.

Fortunately for the fruit grower, he may introduce these new Burbank varieties with less loss of time than usually attends the introduction of ordinary plums.

All of the older varieties in an ordinary California plum orchard require five or six years' growth before they commence to pay for themselves. But most of the new Burbank varieties will commence to bear heavily in the third or fourth season, and by the fifth or sixth year they will have produced as much as the ordinary plum orchard four or five years older.

Why Plant Creation Is Costly

Since I have spoken of the losses sustained by the plant originator in developing fruits that bring such large monetary returns to others, perhaps I should explain a little more at length why

it is that the plant developer who experiments as I have done cannot hope for a quick financial return for his efforts.

One chief reason why experimentation of this order does not pay is that it was done so comprehensively, thoroughly, and on so large a scale.

Where a man conducts plum improvement, for example, as an adjunct to a nursery business, there is no reason why he might not eventually secure even a single improvement that could directly pay him for his care and expense in producing it. There would be no certainty as to this, to be sure, as the chance of securing a really good new variety is not better than about one in ten thousand. That is to say, in handling ten thousand seedlings, there would be no probability of securing more than a single good new variety.

But, on the other hand, sometimes even a small lot of seedlings may give more than one good variety, as has been the case several times.

In any event, the nurseryman can carry out a line of experiment on a moderate scale without considerable monetary outlay. So at worst he will lose very little.

But where innumerable crosses are made and thousands of seedlings are raised each year only to be destroyed; and where all needed improve-

ments are worked for together as in the combination of a great number of species and varieties—instead of taking a certain established variety and attempting to make one or two improvements upon it—there must necessarily be a much greater proportion of expense.

But, so far as my own experiments are concerned, the pioneer work has now been done. I have elsewhere told how the material has been gathered from all over the world, until the plums and prunes of my production carry hereditary strains in their germ plasm from ancestors imported from five continents.

And I have pointed out that there are thousands of new varieties among my plum trees that have exceptional qualities, and from the progeny of which, variously interblended, many new and important races of plums and prunes will doubtless be developed in the immediate future.

The sum total of my work with the plums and prunes, judged by the record of actual introductions, comprises the development of only some seventy new varieties. But it must be understood that these seventy introduced varieties are only the pick among thousands, very many of which were but slightly inferior to the ones chosen. And, as stated before, the final balance sheet for

my work with this fruit cannot be struck for many years to come.

My plum orchard might be compared, in this regard, to a large number of modern industries, manufacturing establishments, for example, which have a high first cost and which cannot be expected to pay more than the interest on the investment for many years, yet which may ultimately show a profit that will pay back the original expenditure and even give a balance on the credit side of the ledger.

Plant Improvements Cannot Be Patented

There is, however, one feature of plant development that puts it on a different plane, as regards probable financial returns, from that occupied by other fields of inventive or creative industry.

This is the fact that nothing comparable to a patent can be obtained on new varieties of fruit trees or flowers, such as the developer of new mechanical inventions or chemical combinations, or artistic productions can depend upon to guard his invention and make it at least probable that he will share in the profits that accrue from its introduction. The plant developer must either introduce his new varieties through direct sales to nurserymen and planters, or else sell them out-

right for a comparatively small sum to a wholesale dealer. In the latter case he receives a sum that is never large. In the former case his returns are altogether problematical, and at best there are only two or three years during which he has a partial monopoly of the sale of the product of his labors.

In three or four years, according to the rapidity with which the new variety can be multiplied, orchardists who have purchased grafting stock can compete in the market with the original introducer.

Suppose, for example, that I have a new plum that I decide to introduce directly. I sell grafting wood by the foot. The highest price I have ever received for grafting wood, even of the choicest new variety, is $10 a foot.

This, to be sure, is at the rate of about $800,000 a cord, if you choose to reckon it that way; but unfortunately you sell only a very small fraction of a cord. There is not likely to be any very active demand for a new variety of plants, or until it has been tested out in several localities. Meantime, the first purchaser, in making the test, has grown a large quantity of twigs from his grafted cions; and with this, obviously, he can enter the market on an equal footing with the original producer.

Thus, a single foot of wood gives enough buds to graft a strong, vigorous, young tree; and from that tree enough wood may be taken next year to graft nearly an acre of orchard. After that, of course, the supply is practically unlimited.

Thus the cost of securing a plum or prune orchard of the very choicest variety is absolutely insignificant; to say nothing of the fact that the enterprising purchaser, when he has demonstrated the value of the new product, can sell grafting wood to his neighbors in such quantities as to pay back many times over his original outlay—even though, as sometimes happens, he makes the sales at only a fraction of the price charged by the original introducer.

In this way, it is clear, any orchardist who purchases cions of a new stock may quickly enter into competition with the original producer or the firm that has purchased the right. Often the second man that comes into the field may take advantage of the advertising done by the first, and quite possibly make as great a profit as the producer and the original introducer. And each local nurseryman may in turn take up the work of distribution, supplying the local demand.

So the few feet of grafting stock that the original plant developer sold for a mere fraction of what it had cost him to produce the new

A GOOD ROOT SYSTEM

The photograph shows a yearling plum having a sturdy, well-branching root system that will provide, in suitable soil, sufficient nourishment for the plant above it. The reciprocal relation between root system and leaf system should be clearly understood by every orchardist.

variety, have within a few years multiplied to make up the thrifty branches of scores or hundreds of orchards, until everyone who desires the fruit is supplied, without an additional cent coming to the pocket of the originator.

This was what I had in mind when I intimated in the beginning that the most successful new fruits, which bring fortunes to a large number of dealers and growers, may represent financial loss to the originator.

Incidental Profits from the New Plum

Not to dwell unduly on this aspect of the subject, however, let me point out a little more in detail some of the benefits conferred by new fruits having exceptional merits.

For example, a fruit may make an exceptional profit for the grower merely because of the fact that it comes into bearing very early in the season, before the market is glutted with fruit of other varieties.

The Burbank, Santa Rosa, Climax, and Formosa plums, among others, are striking examples of this feature, as they come into bearing very early. Several of these have come into the market at a time when it is nearly bare of fruit.

Another advantage is secured to the fruit grower by varieties that are regular and abun-

dant bearers. Regularity of bearing is a factor for which I have worked constantly, and it has been instilled into all my new varieties of plums. These trees are not constructed on the hit or miss plan. They can be depended on to give a crop each year. It requires no argument to show that the expense of starting an orchard can be paid much more rapidly by trees that will bear abundantly each season. An enormous crop every other year would not at all take the place of even a moderate crop every year. But my new plums are not only regular bearers, but most abundant bearers as well.

Sometimes the grower is deceived by receiving a large price for a variety of fruit that is produced in such small quantity as to bring a meager aggregate return.

The wise orchardist, however, will look for a fruit that will produce abundantly and at the same time being a good price per basket. The Tragedy at $2.00 a crate would generally pay much less than the Burbank at $1.00 a crate, owing to the difference in the productiveness of the two varieties. But the Tragedy, even with its small production, averages (according to the returns of last year) only 19 cents a crate more than the Burbank. And of course the Burbank was one of my earliest introductions. Some of

my newer plums quite outclass it in selling value.

All of the most successful of my new plums are early bearers and produce large and attractive fruit. The purchaser desires a large, high-colored, handsome fruit, and he is not disappointed if he finds that it has excellent quality also.

Then, in order that a fruit shall earn money for its grower, it must be adapted to stand shipment to a distant market. Many beautiful plums lack this quality and as a consequence never have been, or can become, valued fruits for commercial shipping by the carload.

But my new plums have been developed with this need constantly in mind. I have recognized that a fruit to become of importance for shipping long distances must have a number of qualities that hitherto have not been required in fruit. It must be of texture that will not break down in handling and shipping; it must retain its flavor, or even have improved flavor if picked before it is quite ripe; and it must remain firm and hard, not only throughout the long journey, but during subsequent days, until it can be placed among the retail distributors.

Very few plums in existence to-day are wholly up to these standards of excellence. The Wick-

son, one of my early introductions, fulfills these conditions better than any other plum before produced. But there are several among my prospective introductions that will excel even this.

Often one new character in a plum, prune, or plumcot doubles its earning capacity. The shipping qualities of the Wickson; the color of the Santa Rosa; the flavor of the Geewhiz or Nixie; the bloom of the Plumcot which enables it to be placed on the market as fresh in appearance as when first taken from the tree—these are examples of characteristics that may double the earning capacity of the fruit.

Incidentally, we must not fail to note that improved varieties of plums and prunes have greatly enhanced the earnings of the transportation companies. Where fruit is shipped by the carload, it can be handled economically by the railways, and as transportation is an essential link between the producer and the consumer, there is no difficulty experienced by the common carriers in securing an adequate price for their work.

Another minor point that might readily be overlooked is that the Burbank plums increase the earnings of the retail dealer, who not only makes a direct profit from their sale, but so beautifies his exhibit by introducing these large

and handsome fruits as to attract customers, and thus facilitates the sale of his less attractive fruit as well.

Finally, the earnings of the Burbank plums advantage the ultimate consumer. The new plums can be produced so much more cheaply that sooner or later this reduction in cost of production will rebound to the benefit of the final purchaser. He gets the fruit at half the former price. The fruit itself is of greatly improved appearance and quality, yet it costs less than smaller, less attractive, and less highly flavored plums formerly cost. So in the end the consumer shares the profit of the Burbank fruits with all the other parties concerned.

If in conclusion I revert to the statement that nobody is made financially poorer except the originator of the fruit, it is only that I may add that he also receives an adequate reward in the knowledge that he is a benefactor of all parties concerned and a detriment to none.

If he can only pat himself on the back, while others may pat themselves on the purse, perhaps his satisfaction after all is not less than theirs.

ACHIEVING THE IMPOSSIBLE THE PLUMCOT

A Cross Which Man Said Could Never Be Made

SEVERAL years ago a party of noted scientists from various parts of the world were visiting my farms.

I asked one of them—an American, then known to the public as a compiler of various books on horticultural subjects—to come over to another part of the grounds and see one of my crosses between the plum and the apricot; one of my first crosses then just ripening.

"There can be no such fruit," my visitor declared. "The two species are wholly different in all respects. Everybody knows it is impossible to cross two trees of such widely varying types as the plum and the apricot."

I was not surprised to hear him make this statement. For at that time very few biologists—and in particular few technical botanists—had quite given up the notion that there are hard and

THE ODD PLUMCOT

This fruit, as the reader is aware, has very exceptional interest because it is a hybrid produced by crossing species so widely separated as the plum and the apricot. The cross was successfully made only after a long series of experiments. Now, however, we have a great number of varieties of plumcots.

fast lines between the different species as commonly classified.

This belief has undergone a radical change in recent years, and the many combinations of widely different species made on my Sebastopol farm have had at least a share in broadening and clarifying the views of the classifiers.

"Well, what kind of a tree do you think this is?" I asked a moment later.

"Why, a plum, to be sure."

"Please examine more closely, professor," I requested. "This leaf looks to me more like an apricot than like a plum!"

"Yes—yes. I see now it is; it is surely an apricot—the leaf, though differing from most of the apricots, is certainly an apricot leaf."

"Now look again, carefully—look at the foliage, bark, branches; and now let us examine the fruit. Then tell me what you really think it is."

After a long and thorough examination, I heard the reluctant decision: "Well, it surely is what you claim it to be—a cross between the plum and the apricot. I never thought it could be made."

I told him I had hundreds of others bearing fruit of different sizes, shapes, and qualities.

"Show me another—quick! quick!"

And he saw not merely one other, but a score or two, to his added mystification.

When the apricot and plum were crossed to produce an intermediate fruit, the accomplishment was thought by some botanists to savor of a violation of the laws of nature.

Breaking Down a Barrier

Notwithstanding the general acceptance of the idea of evolution of species, a reminiscence of the old special-creation point of view lingered. Even if existing species have evolved in the past, they were thought to be fixed in the present; or at any rate to be separated by impassable hereditary gulfs.

If, by a rare chance, species did interbreed, it was quite generally supposed that the offspring must necessarily be sterile.

Therefore, when the statement was made that I had crossed the plum and apricot and produced a healthy and vigorous new fruit, it was met with profound skepticism from most quarters.

But it was only necessary to bring the skeptics to the trees themselves and introduce them to the new fruit to convince them that what they considered impossible had really been accomplished. The plum-apricot hybrid attests

its heritage convincingly to any competent observer.

As we have elsewhere seen, the apricot has been found difficult to improve, because of its lack of adaptability—pliability, as it may be called. The tree thrives, blossoms well, but rarely fruits in this region, chiefly because of the tenderness of its blossoms. Partly because the climate here made it difficult to attempt the improvement of this tender plant, I decided to try crossing the apricot with the plum, which thrives unusually well in this locality.

Had I known how much time and labor and patience these experiments were to demand, they might never have been undertaken. Plant improvement of any kind tests purse and patience; but the improvement of tree fruits strains both to the breaking point. Working with vegetables or flowers, it is possible to get valuable improvements well under way in from three to five years —after which continued selection makes progress more rapid.

With tree fruits you have only just begun after a dozen years of crossing, growing, testing, and selecting.

Nevertheless it was with pleasurable anticipations that I began these experiments which

CHERRY PLUMCOT

This beautiful fruit is a curious combination. The fruit itself is a true plumcot, whereas the stem and leaves are distinctly those of the plum. The coloring and dotting of the skin are characters that reveal the plum parentage; but the other qualities of the fruit are wholly suggestive of the apricot. (Natural size.)

later were to produce the plumcot. It was like entering an unexplored country.

Apricot flowers were dusted with plum pollen and plum flowers with apricot pollen. But for a long time the experiment failed.

Finally, however, when about to despair of success, several crossbred seedlings were found among a lot grown from the seeds of a Japanese plum that had been pollenized with various apricot blossoms.

The young seedlings could be early distinguished readily from the uncrossed seedlings by the foliage, bark, buds, and general appearances; differences being noticeable while the seedlings were still less than a foot high. The combined characters of the plum and the apricot were to be noticed in the bark, the leaves, the buds, and especially the roots. The apricot root is bright red while the plum root is yellow, pale yellow or almost white. The hybrid seedlings had red roots, of various shades.

Battling Heredities

With the recognition of characteristics began the great work of selecting and discarding.

Moreover, fresh hybridizing tests were made and in due course other hybrids were produced, some having the plum and others the apricot for

the seed parent. Where cross-fertilization could be effected, it made no difference which way the species were crossed.

But the conflict of hereditary tendencies was at once apparent. Hybrids appeared that departed widely from the traditions of either parent. Moreover, there was the tendency to sterility that threatens the offspring of every wide cross. One of the first plum-apricot hybrids produced did not have a stamen on the whole tree. It was very evidently a cross of the plum and apricot, but in the combination the means for perfect reproduction was lacking. Experiments were made by applying pollen to the malformed blossoms. But few ripened—the majority remaining dormant.

The cross brings out this striking malformation, but there are doubtless almost numberless tendencies striving for mastery that remain submerged, apparently neutralizing one another—perhaps destined ultimately to come to the surface under the influence of a changed environment.

At every stage of the development and improvement of a plant short cuts must be introduced, where time and expense can be saved.

Instead of waiting years for a seedling to bear, it is possible to save much of that time by the

application of methods of grafting, elsewhere described. Some of the most vigorous and best growers of the hybrid seedlings were grafted onto older plum trees. After two or three years several of them began to bear fruit abundantly.

The grafts showed that fruit would actually be produced—fruit of fine quality; this much was assured.

And it was a fruit of a new order—neither apricot nor plum. In view of its origin, it seemed appropriate to christen the new fruit the Plumcot.

Parental Resemblances

The new fruits are often similar to the plum in firmness and color. In form also the cross quite as often follows the plum parentage, for every shape that is seen among the many thousands of varieties of plums is also seen among the plumcot seedlings. But there are numerous varieties also that closely resemble the apricot in form.

The stones vary widely, some of them almost duplicating the apricot stone, and others being similar to the plum stone. A few varieties have stones which resemble the peach stone in many respects, especially in the corrugated and honeycombed appearance and in thickness of the shell.

SWEET PLUMCOT

Among the hundreds of plumcots which have originated on my experiment farms there is every variation of the combination of plum and apricot qualities. The variety here shown is called the sweet plumcot; it closely resembles the apricot in the quality of its flesh, though growing on a typical plum tree. (*Life size.*)

There is no uniformity in the color of the stones. Some of them are almost white, others yellow; a few are wine colored and there are browns of various shades.

The sharp, knifelike projection from one edge of the stone—a characteristic of the apricot—is found in the seeds of many of the plumcots.

Notwithstanding these extreme variations, however, it is usually not difficult to distinguish between the plumcot seeds and those of the plum or apricot. They are usually plumper than those of the plum, and have an individual appearance that would be noticed by anyone who examines them.

Some stones are attached to the flesh, while others are free, some are smaller than the stones of either the plum or apricot, while some are much larger, almost comparable to the peach stones.

The flesh of the new fruit is—the flesh of a plumcot.

As great production as could be desired, combined with large size and other good qualities, had not up to that time been produced. This lack, while discouraging for the time, was by no means an insurmountable obstacle to the production of a fruit comparable in its relative perfection to our other standard fruits.

When it is possible to add to the most stubborn plant, practically any desired element—color, hardiness, earliness, or any other it may lack—the plant improver may be assured that productiveness can also be added.

In order to give an idea how a number of seedling plumcots proved up, the following test records of some of the plumcots produced are listed. It is to be remembered that these are some of the results of earlier experiments.

On consulting my record books, I find that the earlier plumcots were usually listed as poor to medium growers, and almost without exception as poor bearers. Such records as these are typical: "No. 10—Poor grower; fruit small. No. 14—Strong grower and poor bearer. No. 16—Poor grower and poor bearer. No. 18—Medium grower and poor bearer."

This is not as discouraging as it might seem on the face of it. All of the trees represented by the above numbers bore regularly; they produced a fair crop every year. Moreover, there were others that were listed as "medium" bearers, and even as "heavy" bearers.

One of these now fruiting produces such an enormous quantity of fruit that it would seem impossible for the tree to hold it; the branches

are literally crowded with plumcots from base to tip.

The quality also is good. So this variety gives a good basis for more seedlings and for crosses that will produce regular and abundant bearers of fruit of superior quality.

The plumcot was at first slow of improvement owing to the comparatively few seeds available, and the time it took those to come again to bearing, yet a number of varieties which combine the pleasing quality of the apricot with the hardiness and productivity of the plum are already in existence.

The larger proportion of the successful crosses between the apricot and the plum have been made with the Japanese plums. Few seedlings have been raised from the apricot trees pollenized with the Japanese pollen, the seeds generally being produced from the plum tree.

The seedlings of the second generation show an astonishing number of variations. Although both trees and fruits of these variations usually resemble both parents in various respects, yet we are so unaccustomed to seeing such combinations of characters that they appear to be new.

In fact, the *combinations* are new, though the characters exist in the heredity of one parent or

ONE OF THE NEW PLUMCOTS

The typical plumcot differs so widely from either of its parents that it is entitled to be called a distinct species. Some varieties, however, show a peculiar segregation of the parental characteristics. The specimen here shown reveals the plum ancestry in the mottled character of its skin, while the seed, blossom end of the fruit, lopsidedness, firmness of flesh, and round, smooth stone, indicate its apricot parentage.

the other; but these are often greatly intensified in certain individuals.

Further Characteristics of Tree and Fruit

The foliage, growth and general appearance of the plumcot trees most often combine the characters of the two species in such a way that it is impossible to classify them either as plums or apricots. There are, of course, many gradations, so that some trees much resemble the plum, while others closely resemble the apricot.

Several varieties of the new plumcots were exhibited at the Pan-American Exposition at Buffalo in 1901. The exhibit aroused interest—both for its novelty and beauty and because of its promise of a new fruit for the orchardist.

As announced in "The California Fruit Grower" of May 24, 1903, a special gold medal was struck as an award—though no award had been scheduled, or could have been for any such exhibit. Such fruit had probably never been thought of by the board of awards or anyone else.

Such recognition was pleasing. Yet the plumcot in 1901 was far from being a perfect fruit. It was rather in the experimental stage. Further

work in crossbreeding and selection was requisite for its perfecting.

The first one of these plumcots introduced was sold to John M. Rutland of Australia.

Mr. Rutland came from Kiewa, Australia, and lived near my Sebastopol proving grounds for several years in order to study these new fruits, as well as the cactus and other of my productions. When he saw this plumcot, he thought it good enough for introduction. Accordingly, in July, 1905, he purchased the right of distribution in the Southern Hemisphere, including all of Africa. He named this variety the Rutland.

The following year the new fruit was introduced in the Northern Hemisphere by George C. Roeding of Fresno, California.

The Rutland has long, slender branches, and long, slender leaves. It is a completely balanced combination of the Satsuma plum and the apricot. The exact pedigree of the Rutland is inferred rather than known. The crosses were so numerous and so complicated at that time that no attempt was made to keep an exact record of all of them. There can be no doubt, however, that Satsuma is one of the parents, because the flesh of the Rutland is red, and the Satsuma was the only plum which had red flesh that I was using for crossing at that time.

The fruit of the Rutland is large, globular, clingstone; both the flesh and the skin are of a deep crimson color. The flesh has an acid flavor until mature, and when fully ripe resembles the Satsuma in its acid qualities. Its principal value is for jams and jellies. There are a dozen or more bearing trees of this variety on the Sebastopol place, and they have never failed to produce a crop each season. The amount of fruit, however, is too small to make trees valuable commercially in this climate.

The Rutland was a fruit of unusual scientific interest, and was introduced partly under that consideration—not merely as a commercial fruit. It was sent out as a curiosity, the type specimen of a new kind of fruit and the forerunner of numerous good varieties that will follow.

Fixity of the New Species

It might be thought that seedlings from plumcots would revert to the type of plum or of apricot, but they do not. The combination is complete and permanent. Among the many thousands of seedlings which have been grown, not one has produced either true plum or true apricot. All are plumcots. It is therefore plain that the new fruit is fixed as a species.

CLUSTER OF APEX PLUMCOTS

This variety of plumcots shows a pretty even balance of the characteristics of the plum and apricot ancestors. The fruit is very large for an early bearer, being from 5½ inches to 6 inches in circumference. The flesh is honey-yellow, firm, rich, aromatic, resembling that of the apricot; sweet and delicious. The Apex is the only plumcot yet introduced which has promise of becoming a standard market and shipping variety, though there are others equal or superior to it in the proving orchard. The Apex is already shipped East in large quantities. (Nearly life size.)

Of course it is not expected to fix any of the varieties so that they will come true to seed, any more than any variety of plum or apple or pear will come true to seed.

Nevertheless, the mixed heritage of the new fruit is not altogether obscured. The tendency to segregation of plum factors and apricot factors in the second and succeeding generation is variously manifested. It would probably be feasible to select specimens that by inbreeding and selection could be made to develop races fairly duplicating each of the parental stocks. Such an experiment would have scientific interest rather than practical value.

The plumcots are still new; they have not been introduced to the general trade long enough to be fully tested in many parts of the world. It was hoped from the outset that among the new varieties some would be found bearing fruits equal to or better than the apricot in flavor, on trees at least as hardy as the standard varieties of plums.

This expectation has been realized in a variety of plumcot that has been named the Apex.

This makes it possible to raise delicious apricotlike fruits in many localities where the apricot cannot be grown.

The Best of the Plumcots—Up to Date

The best of the plumcots so far produced is that just mentioned, the Apex, a final selection in 1911. It ripens with the very earliest of the early plums, about June 10. This means that its season is about three weeks earlier inland. It is now extensively grown and is meeting with special favor as a shipping fruit.

The tree is a strong, upright grower and has never failed to bear a full crop, even where apricots are failures. In some cases the Apex has borne a full crop of fruit even when the plums were a short crop on account of unusual weather conditions. This fruiting capacity is unusual in plumcots of such superior quality, and marks the beginning of a new race of plumcots as productive as the plum and as valuable as the apricot.

The fruit of the Apex is extremely handsome, and very large for an early fruit, being 5½ to 6 inches in circumference. It is globular, and pink or light crimson in color. The flesh is honey yellow, firm, rich, aromatic, resembling that of the apricot, and sweet and delicious to the taste.

The Apex tree is a much stronger grower than the Rutland, and produces perhaps ten

times as much fruit. The fruit is larger and much earlier. It has yellow flesh instead of crimson, making it one of the most valuable market varieties.

The Apex resembles the apricot very decidedly in form, size, and quality of fruit, while it is more like the plum in foliage, upright growth, productiveness, and smooth-skinned fruit. It thus illustrates the tendency to segregation of unit characters along those lines to which reference has been made.

The Apex is the only plumcot yet introduced which has promise of becoming a standard market variety, though there are others equal or superior to it to follow. Its ability to withstand the requirements of long shipping have been thoroughly tested, its firm flesh and tendency to ripen slowly are sure indications of its value for transcontinental shipment.

The exact parentage of the Apex is not known. The crosses have been so extensive and complicated that a complete record was thought of less value than the production of a fruit that would feed the millions. It is certain, however, that the Apex, like the Rutland, carries blood of the Japanese type of plum combined with that of the apricot.

ANOTHER PLUMCOT

It is not unlikely that still better plumcots will appear in the course of successive seasons. This beautiful and delicious fruit has Satsuma flesh, and apricot stone and flesh texture, with stem and other fruit characters well balanced between the plum and the apricot. It is an appetizing and palatable fruit.

The Triumph plumcot was introduced by myself in 1911, having been, like the Apex, previously tested for several years. It is fairly productive here, the fruit ripening about August 1. It is of apricot form, is six inches around, with velvety purple skin, thickly dotted and mottled with scarlet. The flesh is firm and apricotlike in texture. It is not so promising as a shipping fruit as the Apex because of its deep crimson flesh and lateness of ripening.

The Triumph is primarily a home fruit, and is valuable because of unique combinations of the apricot and plum qualities.

During the several years this variety has borne fruit the trees have never failed to bear at least a medium crop.

Another plumcot introduced at the same time as the Triumph is known as the Corona. It is a strong, upright-growing tree, bearing beautiful, large, golden-yellow fruit with a velvety skin. The fruit usually develops a red cheek when perfectly ripe. It is firm, sweet or subacid, and delicious. The Corona is a clingstone. It ripens July 25. It is an unusually rapid-growing tree, but it is not so productive as the Apex. It will probably be grown only for home use. It is possibly hardy enough to be grown in many localities where the apricot does not fruit, and may be

appreciated there because of its resemblance to the apricot. Besides the varieties that have been introduced, I have some thirty other selected varieties that have been given temporary names, for further testing. Some of these will doubtless be introduced if, as expected, they prove of value.

Hundreds of other seedlings are being tested but have not developed sufficiently to give a very definite idea of their qualities.

Hybridizing the Plumcot

Now that the plumcot race has been thoroughly established, it is necessary to make further crosses.

The obvious way to obtain improved varieties is to cross the best seedlings of those already produced. This is being done every year. Seeds of all of the plumcots grown on my place in 1912 were saved and planted; possibly two thousand of these seedlings being grown.

One of my named varieties that has not been introduced is perhaps one of the most prolific fruit trees ever produced. The seeds from this are being saved separately. It is very probable that the seedlings grown from this variety will be remarkable producers.

By crossing some of the plumcots with the *Prunus Pissardi* plum, some purple-leaved plum-

cots have been secured. This characteristic of dark foliage is as readily transmitted in the plumcot cross as it is in the plum crosses. It is expected that by this cross one or more varieties of plumcots will be secured that are valuable both for fruit and foliage.

The purple-leaved plum trees have proved of great value for decorating lawns, and the plumcot trees are considered of even more value by some, because of the unique combination, and the brilliant color of the foliage.

From a study of the plumcots already produced, it is safe to say that this new fruit will become known and grown in all climates where deciduous fruits are found. Numerous improvements must be made before the plumcot will become as popular as either of its parents. But only time and patient selection are required to effect these improvements.

It is quite possible that in many regions the plumcot may in time replace the apricot as well as many of the plums.

But more important even than the quality of the plumcot as an orchard fruit is the lesson it has taught as to the possibility of producing new fruits by hybridization.

The plumcot stands as the first addition to the list of orchard fruits that has been developed

THE "BURBANK" PLUMCOT

This is one of the most delicious of the plumcots. It will be seen from the direct-color photograph print that this variety resembles the common cultivated crab apple in appearance. This is probably accounted for by the fact that one of the ancestors in the original cross had the shape of the crab apple; though this plumcot is otherwise very different.

within historical times. Apples, pears, plums, peaches, cherries, apricots, quinces—all were known to the Romans and Greeks and to their forbears of Oriental antiquity. The plumcot is a new species that originated just at the close of the 19th century.

Its production forecasts a new era in fruit development.

Plant improvement of any kind tests purse and patience; at every stage of the work short cuts must be introduced in order that time and expense may be saved.

THE THORNLESS BLACKBERRY AND OTHERS

Some Transformations in the Bramble

THE nursery rhyme about the wise man and the bramble bush will probably have little meaning for our grandchildren. For the brambles of their day will have no thorns with which to scratch out eyes—let alone scratch them in again.

The thornless blackberry is an accomplished fact, as thousands who have grown them will testify; and the value of thornlessness in a berry-producing vine is so obvious that the new product cannot fail to supplant the old type.

Whoever has visited a blackberry or raspberry patch of the old type and attempted to gather the fruit, will recall, doubtless, bringing away souvenirs in the form of scratches that were far more lasting than the fruit itself.

When those who have the recollection of such souvenirs see the transformed plants and mammoth clusters of large, beautiful, sweet black-

berries growing on vines as smooth as pussy willows, the impression gained is both vivid and lasting that this is a plant improvement of a very notable order.

In fact, there is perhaps no other single plant development in connection with small fruits that constitutes so radical a change and so conspicuous an improvement as the removal of thorns from the blackberry. The bush itself no longer needs the thorns to protect it against marauding deer or sheep as it did in the days when it grew in the woodland or nestled in fence corners. On the contrary, as we have elsewhere suggested, the thorns are now detrimental to the plant in that they take a certain amount of energy and building material that might be put to better use.

And from the standpoint of the horticulturist, the thorn is not merely a detriment; it is a nuisance of such significance as materially to interfere with the cultivation of the blackberry and very greatly to reduce its popularity.

It may confidently be predicted that, once the thornless blackberries are generally introduced, the really delicious fruit that the blackberry produces will be seen far more commonly in the market than it has been in the past, and will soon achieve the popularity that it deserves.

How the Blackberry Lost Its Thorns

As long ago as 1880, while I was still following the pursuit of a practical nurseryman and giving a divided attention to plant development, many experiments were made in the attempt to produce thornless berries. But these experiments were nearly total failures.

The plant with which I first worked was a blackberry bush known as the Wachusett Thornless, which was introduced and alleged to be thornless about 1880. I raised seedlings from this plant, and also crossed it with other blackberries. But being much preoccupied with other experiments and greatly handicapped for means, I therefore neglected to carry the experiments to a practical conclusion.

The Wachusett, which had been found partially thornless in the state of nature, had a goodly supply of thorns distributed here and there over the plant. It had fewer briers than most other blackberries, to be sure, but it was by no means the sort of bush to handle with impunity or rub against your face without the slightest danger, as may be done with the thornless blackberries of to-day.

The Wachusett was not of a really smooth stem, and it had almost nothing else to commend

THORNLESS BLACKBERRY AND THE RECREANT SEEDLING

At the left a typical stem of the new blackberry; at the right a thorny seedling. The thornless blackberry invariably breeds true to thornlessness; so it is to be surmised that this seedling is the result of a chance fertilization with the pollen of a thorny variety.

it. Its berries were quite small and lacking in flavor, and it had moreover the pestiferous habit of suckering from the roots. So it naturally did not achieve popularity. Nor was anything heard of any other blackberry that laid claim to thornlessness until about ten years later.

Then it chanced—in the year 1902—that Mr. David G. Fairchild, of the United States Department of Agriculture, found in North Carolina a few plants of a wild dewberry, apparently *Rubus canadensis,* that were nearly thornless. Mr. Fairchild and myself had frequently exchanged specimens of one kind or another that were thought to be useful in this work. He now very kindly sent me a few ripe berries picked from the partially thornless dewberry.

The seeds were carefully planted in boxes in my greenhouse. Of the several hundred seedlings that these produced, probably about one or two in the hundred were nearly or quite destitute of thorns.

These few almost thornless plants were carefully selected, all the remainder being destroyed.

From the fruits borne by these selected plants, a second generation was raised, from among which it was possible to select a number that were absolutely free from thorns—showing no sign of any spicules on either stems or leaves.

More than fifteen thousand seedlings were raised from the fruit of the best of these thornless plants, and out of that large number not a single specimen showed any tendency to develop thorns, every one being as smooth as the branch of an apple tree.

Thus by inbreeding and selection from fruit produced by a partially thornless wild dewberry, a race was quickly developed of thornless berries and could be depended on to breed absolutely true as to thornlessness.

If we interpret the facts of this development in the light of later experience, we may infer that the condition of bearing thorns is prepotent or dominant over the condition of thornlessness in the blackberry. Thornlessness is, then, a recessive trait which will be submerged in a cross between a thorny bush and a thornless one, but which will reappear after the manner of recessive traits, in a succeeding generation, provided two individuals of mixed heritage are interbred.

The fact that only a very small percentage of my first seedlings grown from the seeds Mr. Fairchild sent were almost thornless, suggests that the flowers of the bush on which they grew had been chiefly fertilized with pollen from thorn-bearing bushes. The fruit from such a pollenization would produce thorny bushes ex-

clusively, owing to the dominance of the factor for thorns. But if a few berries or individual drupelets of a berry had been fertilized with pollen from a flower of the thornless plant itself, these would (according to a formula with which we are already familiar) stand one chance in four of combining recessive factors and thus of producing thornless progeny.

And of course from then onward the case presented no difficulty as far as this character was concerned. We must now be at hand to make sure that the thornless flowers were fertilized solely with pollen of their own sort. This, of course, could bring together only recessive factors, that is to say, factors for thornlessness, and the result could not be in doubt. The thorn-producing factor would be left entirely out of the composition of bushes sprung from such a union, and they would inevitably be thornless.

Thornless, but Lacking Quality

But while the production of a thornless race of dewberries was thus accomplished with comparative ease, it must be understood that this was really only the beginning of the task.

The original berries from which the thornless vines were grown were of no commercial value. They were small and of very indifferent flavor.

To have produced a thornless race from them was an interesting scientific achievement, but one that at this stage had no very practical significance.

In order that the experiment should lead to the practical results at which I aimed it was necessary now to improve the fruit of these thornless protégés. And, while something could be done in this regard by mere selection—in which case, of course, there would be no danger of having the plants backslide from a thornless condition—I soon found by experiment and observation that selection alone would be much too slow and doubtful a method for the development of such fruit as would be necessary to compete with the highly developed blackberries already in the market.

For of course it could not be overlooked that the ultimate purchaser is much more vitally interested in the quality of fruit supplied him than in a question of whether this fruit grew on a thornless vine or on a brier brush.

By the time I had reached the conviction that it would be necessary to adopt a more energetic procedure than mere selection in the education of the thornless berries, I had acquired through experience a very clear comprehension of the methods that must be depended on to inculcate

the desired lessons. I knew that crossbreeding afforded the only feasible means of introducing good qualities into the fruit of the thornless dewberries.

Now the work of developing took on aspects closely comparable to those that we have already reviewed at length in the development of orchard fruits. It was necessary to bear in mind such items as increased size of fruit, good flavor, firm flesh, and time of ripening—all of these being matters regarding which the thornless berries were defective.

Improvement Through Hybridizing

Of course there was no dearth of material with which to effect hybridization.

The dewberry is merely a trailing variety of blackberry, and it crosses readily with all other species of blackberry.

I had at hand any number of blackberries bearing fruit of the finest quality. There would probably be no difficulty whatever in producing hybrids between the little thornless berry and the Lawton blackberry, for example, or my new Himalaya berry, or any one of a dozen others. And some of these would give, among varying seedlings, a certain member that would bear excellent fruit.

But, unfortunately, when such crosses were made, it was at once apparent that the thorny condition had shown prepotency, and all the seedlings that grew from thornless berries thus cross-fertilized were seen to be bearers of thorns.

This was precisely the experience that had disheartened me when, back in 1880, I had made the experiments with the Wachusett partially thornless blackberry, to which reference was made above. But in the intervening time I had made many thousands of hybridizing experiments, and I now clearly understood—what at the earlier period I had known vaguely if at all—that in such a case as this we must look to the second filial generation for the kind of results we are seeking.

The case is precisely comparable to that of the white blackberry, for example, or to that of the stoneless plum. When the white blackberry is crossed with a black blackberry all the offspring of the first generation are black. And when the stoneless plum is crossed with the stone-bearing plum all the offspring of the first generation are stone-bearers. But in each of these cases the succeeding generation will show individuals in which the submerged character reappears—we shall have white blackberries and stoneless plums again.

So I have every reason to believe that a comparable result would be achieved if the thorny hybrid seedlings born of my thornless race were given opportunity to redeem themselves in their progeny.

The expectation was justified. In the second filial generation the thorny seedlings produced a certain proportion of thornless progeny. And some of these thornless bushes now bore fruit far superior to that of their thornless grandparent. They had inherited some of the good fruiting qualities of their thorny grandparent, even though they had repudiated his thorns.

This was obviously encouraging. So the experiment was continued along the same lines through successive generations. Selection was made of course of the one specimen in each generation that inherited the best combination of desired qualities and hybridized, in successive generations, the Lawton blackberry, the giant Himalaya, and various others, to gain size of berry, earliness of bearing, new flavors, more acid, and, in a word to supply whatever defects could be discovered.

The original thornless berry was a late bearer and its fruit lacked size, spiciness, and refreshing acidity. But these qualities were supplied in abundant measure through successive crosses.

ONE OF THE NEW THORN-
LESS BLACKBERRY
CLUSTERS

Should any doubt remain that this curious plant with its absolutely smooth stem is really a blackberry, a test of the fruit will at once convince the most skeptical. Not only is this a thornless blackberry, but it is a fruit of very superior quality. It has the peculiarity of maturing very late in the fall.

One seedling in particular, grown in 1906, had exceptional qualities, and the subsequent stock was largely grown from the fruit of this single bush. Like its fellows, it bore strains of half a dozen races of high-grade market berries, blended with the thornless strain.

Of course each successive crossing with a bearer of good fruit meant the introduction of thorns in the seedlings of the next generation. This was inevitable, since of course all the bearers of commercial blackberries were bearers also of thorns. The Himalaya in particular is an exceedingly thorny bush, and the otherwise commendable Lawton is an almost equal offender. But whereas these thorny shrubs were prepotent in their influence over their direct offspring as was expected, some of their grandchildren always reverted to the thornless state.

And so here, as in various other experiments already described, advance was made by indirection. We are forced to seesaw back and forth in successive generations between thorny bushes and thornlessness; yet on the whole there was progress, inasmuch as each successive generation gave better qualities of fruit, and each alternate generation the recurrence of the thornless condition.

Inasmuch as the thornless bushes, of whatever generation, will breed true to thornlessness if fertilized among themselves, it is obvious that each thornless generation constitutes a fixed race, provided the plant experimenter does not elect to disturb its fixity by a new hybridization.

The result, up to date, is that after twenty-four years of selective breeding along these lines, the descendants of the little North Carolina dewberry (who are descendants also, of course, of various and sundry berries of more aristocratic bearing) constitute a race of blackberries growing on large, well-shaped, spreading bushes that are always absolutely thornless. The fruit itself is a large, handsome, glossy blackberry, of excellent flavor, profusely clustered—a fruit that makes inviting appeal to all and which will exact no penalty in the way of scratches from those who gather it.

The story of the thornless blackberry is thus told at length because the development of this fruit quite eclipses all my earlier work with the blackberries, and makes the record of the development of the thorny varieties, however excellent their fruit, seem an almost archaic performance.

It must be recalled, however, that the present thornless blackberries of superior quality could

not have been secured so expeditiously had not material been at hand for the hybridizing experiments through which size and flavor were bred into the fruit until, as just related, the perfected thornless varieties were developed.

And this material was largely the product of some earlier experiments through which blackberries of the old type had been improved as to their fruiting qualities.

It is necessary, therefore, in the interests of completeness, to retrace our steps and briefly to review the earlier experiments—some of which indeed, were carried forward coincidentally with the development of the thornless—through which new races of blackberries of exceptional quality, though still handicapped by thorns, were developed.

In this connection it is interesting to recall that the cultivated blackberry is essentially an American product. No other country until quite recently has appreciated the quality of this fruit sufficiently to cultivate and develop it. Wild species, to be sure, are abundant in Europe, growing everywhere in England and in Ireland, along hedges and in waste places; but the horticulturist has all along seemingly been prejudiced against the fruit, mostly perhaps because of its offensive briers.

The prejudice against the wild bramble was retained by the Colonial settlers of America—retained so persistently that fully two centuries were needed for this excellent berry to make its way into the fruit gardens.

Not a single horticultural variety of blackberry was introduced until almost the middle of the nineteenth century. Then the Dorchester was brought to notice, and about a decade later a better berry, the Lawton, which is still a standard, and two other varieties, the Holcomb and Wilson's Early, were brought to the attention of fruit growers.

As a significant industry, blackberry cultivation is even more recent. It has almost wholly developed since 1870. It began with planting, on a commercial scale, the Lawton, which was later supplanted by the Kittatiny in some sections. This in turn gave way to the Snyder, and still more recently better varieties were developed. The evolution of the fruit had been gradual, but it has at last established a place in the horticultural ranks. I repeat my prediction that it will gain a new impetus now that the one great drawback of the blackberry, its thorny stem, has been completely eliminated.

It will take some time, however, to spread the thornless berry universally, and in the meantime

the blackberries of the older type retain a measure of interest.

Materials for Development

The chief American wild species, which furnished material for the development of the races just named, are the common Eastern blackberry (*Rubus nigrobaccus*), familiar everywhere throughout northeastern America, and a closely related form, considered by some botanists a mere variety, known as *Rubus sativus*.

The common wild plant is an upright grower, stout, has little recurving canes that are usually deeply furrowed lengthwise, and clothed with stout more or less hooked prickles.

The other species or variety is slightly more erect, with fuller and firmer canes, differing somewhat also as to shape of leaves. It bears berries that are usually rounded, generally soft and juicy, and of superior flavor. At my old home in New England this variety grew abundantly on sandy soil, being one of the best wild blackberries in that vicinity. Very early I had noticed that this plant was inclined to vary widely. For example, the vines, although usually stiff upright growers, sometimes more resembled the common blackberry, or even tended to take on the trailing habits of the dewberry.

When I came to know more about plant development this tendency to variation was recalled, and here, as always, a fruit of this tendency should furnish material for the development of improved varieties.

In due course I worked with the various cultivated varieties of blackberry, and soon developed some improvements, particularly with reference to the size of fruit, its flavor, and lengthening the season of fruit bearing.

One of the improved varieties with which I worked had been lately introduced under the name of the Early Harvest; another was named Wilson Junior. But the most notable results attended the use of the native species, and in particular the introduction of foreign species from remote parts of the earth.

As early as 1879 I was earnestly working on varieties of blackberries, and of raspberries as well, that were obtained from my collector in Japan, combining these with other wild and cultivated varieties from various sources.

The first really notable success, however, came about through selection, without the aid of hybridizing, from a berry that I had introduced from India. This berry, in recognition of its origin, was named the Himalaya, sometimes shortened to Himalya.

The Prolific Himalaya

The seed from which this improved blackberry grew was obtained from India through exchange.

It would appear that transplantation to an altogether new soil and climate had the same stimulating effect upon this blackberry that we have seen manifested in the case, for example, of the Japanese plum, the New Zealand winter rhubarb, and sundry other plants. For there appeared among seedlings of the second generation an individual that was a very marked improvement over its parents.

This exceptional seedling was cultivated and propagated, and its qualities proved so unique that it was introduced in 1885 by a special circular, being christened, as just stated, the Himalaya.

After the usual decade or so of probation, during which every new fruit of whatever quality must wait for recognition, the Himalaya took its place, first on the Pacific Coast, and later in some of the Central States and in foreign countries, as a standard blackberry. After it came to its own, so to speak, its popularity was so great that for several years the plants could not be multiplied fast enough to meet the demand.

It is a plant of extraordinary vigor. A single cane may grow more than twenty-five feet—sometimes even fifty feet—in a season, and attain near the base a diameter of an inch to an inch and a half.

The aggregate growth of cane of a single plant in a season may exceed a thousand feet—one fifth of a mile.

And in point of fruit production, the Himalaya far surpasses any other berry plant ever grown. Reports tell of a single bush bearing two hundred pounds of berries in a season.

"My daughter and I picked fifty pounds of berries from one Himalaya bush the latter part of August, 1906," writes one enthusiast, "and we scarcely missed them from the bush. This was after many others had picked from the same bush. I picked three pounds standing in one position. I could have picked double that amount if I could have reached into the bushes farther, but the entangled branches with their sharp thorns prevented me."

The narrator adds this comment: "It is my opinion that if this single bush were properly pruned, fertilized, and irrigated, as well as shaded from the extreme heat of the sun in July and August, it would bear between three and four hundred pounds in a season."

Such a report is typical. The prolific bearing of the Himalaya is the subject of astonished comment from everyone on seeing this extraordinary vine for the first time.

The fruit itself is of medium to large size, unusually sweet, and spicy, with small seeds, and extra fine in quality. The berries grow in clusters sometimes a foot or more across, and they continue to ripen after most other blackberries are gone.

If not pruned, the vines of the Himalaya will grow to a length of one hundred feet or more, like grapevines. They appear to be absolutely resistant to disease, and have recently shown the ability to resist the extreme cold of Michigan and the far Northern States. It should be known that the Himalaya takes a year or so more to come to its best bearing condition than ordinary blackberries, but when in full bearing a single plant will produce as much as a dozen ordinary blackberry vines.

The elimination of the thorns is a matter to which sufficient reference has already been made. As to abundant bearing, nothing more is to be desired. The improved Himalaya at present produces all the berries that a vine can possibly support.

Development Through Hybridization

As the experiments in the development of the blackberries continued, I quickly passed from the stage of selection to that of crossbreeding and hybridization.

The plants utilized in these experiments included not only all types of native blackberries proper, and numerous foreign species, but plants of the allied race of dewberries.

The dewberry, to be sure, is closely related to the blackberry; it is, indeed, a blackberry that has assumed a trailing habit. Or possibly the case would be stated more truly if we say that the bush of the blackberry is a dewberry that has risen from the ground and assumed the habit of upright growing.

There is, nevertheless, a sufficient divergence to make the dewberry seem to casual inspection a plant of distinct type. And, at the time when my experiments were begun, there were probably few plant developers who would have supposed it possible to hybridize even the dewberry with the ordinary blackberry.

Successive crosses were effected, nevertheless, at an early stage of the work, and in the course of my experiments the interblendings were so numerous and intricate that seedlings were

produced showing all gradations of habit between the trailing vine and the upright one; as well as all gradations of leaf and fruit form and quality.

Sometimes when crossing a blackberry with a dewberry the trailing habit is greatly intensified, the hybrid being a long, vinelike, straggling plant. Again, the result may be just the opposite, a tall, upright, almost treelike plant being produced. Some hybrids would run a distance of at least fifty feet. Others, perhaps of the same fraternity, would take on so treelike a habit that their fruit could be reached only with the aid of a stepladder.

But perhaps the most singular and interesting anomaly was that some of these hybrids bore flowers and fruit in every month of the year, though sparingly. At the time when I had a large colony of blackberry-dewberry hybrids, ripe berries could be picked from one bush or another almost every day throughout the year.

The possibility of producing, with the aid of such hybrids, commercial varieties of blackberries that will fruit at all seasons is inviting. Experiments already far advanced have greatly extended the blackberry season, and there is reason to expect that the blackberry lover in the future will be able to secure this fruit, in one variety or

another, from early spring until almost the onset of winter.

As to other possibilities of blackberry development, something was said in the earlier chapter that described the development of the white blackberry. But much remains to be told. The chief development, however, through which not merely new varieties but new species of berries have sprung from the amalgamated stock of the forty-odd species of bramble fruit with which I have experimented, have had their origin in hybridizations that linked the blackberry with its relative the raspberry.

The account of the altogether notable results that have arisen from this alliance is an integral part of the story of the blackberry. But it may be told to best advantage in connection with the story of the raspberry in the succeeding chapter.

The thornless blackberry is an accomplished fact, and the value of thornlessness in a berry-producing vine is so obvious that the new product will not fail to supplant the old type of brier bush quite rapidly and effectually.

THE RASPBERRY AND SOME ODD CROSSES

MUCH BETTERMENT—AND A FEW BAFFLING PROBLEMS

LET us take up the story of small-fruit development where the preceding chapter left it. We are still concerned with the blackberry, but we now have to do also with the companion fruit, which is obviously a not very distant relative, yet which has certain typical peculiarities that mark it as belonging to an altogether different branch of the race of brambles. Most conspicuous of these is the fact that the ripe raspberry separates from the receptacle when picked, whereas the blackberry is permanently attached to the receptacle.

The raspberry, unlike the blackberry, has been cultivated in Europe from an early period. The red raspberry, in particular, grows wild all over Europe, from Greece to Spain and northward to Norway and Sweden. It was originally christened *Rubus Idæus,* after Mount Ida in

Greece. Like other cultivated plants, it tends to vary, and it is said that more than twenty varieties were under cultivation in England a century ago.

The American colonists introduced this favorite European berry at an early date, but it did not find a congenial environment in the new country. The long, cold winters of the Northern States, and the dry heat of the Southern summers were alike hostile to it; and its lack of hardiness denied it general recognition except as an occasional garden plant.

But the new continent possessed many wild raspberries that were of course adapted to the environment, and in time these came under cultivation. Their introduction, however, was so gradual that it was quite unnoticed. The only raspberry cultivated extensively for the New York market early in the nineteenth century was known as the English Red. It is believed to have been an offspring of a native berry, known as *Rubus neglectus* (itself believed to be an accidental hybrid of our wild red and black raspberries), but this was not generally known, and the name given the fruit suggests that it was supposed to be of European origin.

During the latter half of the nineteenth century many improved red and yellow raspberries

were introduced, and various of these have been utilized in my hybridizing experiments.

But perhaps the chief favorite among American raspberries is the one introduced in the early forties by Nicholas Longworth of Ohio, and known as the Wild Black or Blackcap Raspberry, *Rubus occidentalis.*

This berry was a great addition to the list of cultivated fruits. It soon became a favorite everywhere it could be successfully grown. Mr. Longworth himself introduced it into England, but it did not thrive in the English climate and it never competed with the native European species.

Interbreeding the Raspberries

The familiar cultivated raspberries of the present time owe their origin to the species just named, and to two other allied species, one our wild red raspberry, *Rubus strigosus,* a close relative of the common European species, the other known as *Rubus leucodermis,* a western relative of the familiar blackcap.

All the red raspberries now under cultivation have sprung from either the European or American red species. The Purple-cane type apparently sprang from the *Rubus neglectus* (very probably a hybrid between *R. strigosus* and *R. occidentalis*); such varieties as the Reliance,

THE FAMILIAR BLACKCAP RASPBERRY

This is the familiar wild black raspberry or Blackcap. The specimens here shown are better than the average run, having been improved in size and quality and the plants in productiveness by means of careful selection. They represent the species unmodified by crossing, however.

Shaffer, Philadelphia, and Gladstone are, at least in part, probably of this origin, as was the historical English Red. The Purple-cane was a native of the northeastern part of the United States, being common in New York and vicinity.

The original American red raspberry, *Rubus strigosus,* first became known to the horticultural world in 1860, through the introduction of Allen's Antwerp and Allen's Red Prolific.

For several years preceding 1880 I had been raising seedlings of blackberries, raspberries, gooseberries, Juneberries, strawberries, currants, and various other berries on my experiment farm, and many variations were developed in that way which aroused my enthusiasm.

These experiments were largely instrumental in teaching me the then not known or not generally accepted value of cross-pollenizing as the means of introducing the tendency to vary among existing species or varieties. And my experiments with the different raspberries had a prominent share in the demonstration of this very important and hitherto unappreciated principle.

In the course of these experiments it was first found that the blackcap would cross with the red raspberry, although with difficulty.

Seedlings from this cross sometimes bore perfect berries abundantly, but much oftener they

bore imperfect berries having perhaps only two or three seeds. Again, after blooming, there would be no development of fruit, only a core or stem remaining.

Among some of these crosses I met with a difficulty not encountered in crossing any other of the members of the great *Rubus* tribe. The plants at first seemed sickly, having little or no vitality. When transplanted from greenhouse to open field they made little growth the first season and the second season at about the time for fruit bearing they all seemed to fail utterly.

Every seedling among a lot of these hybrids would sometimes thus be suddenly destroyed.

In continuing the experiment, I found that there was strong individuality among the different plants, so that some of the red or yellow raspberries crossed readily with the blackcaps, while others failed to do so; there being all gradations. In some cases the resulting seedlings would show the prepotency of one parent or the other. But, generally, in the first generation there would be a blending of the characteristics of the two.

Underlying Principles

At that time no plant developer fully realized that all the best variations and recombinations in a hybrid stock appear in the second and a few

succeeding generations. A recognition of this principle constituted my first very important step toward the development of new forms of plant life.

I discovered, in connection with the raspberry hybrids, that in the second and a few succeeding generations different combinations were brought out in the most wonderful variety; and that from these certain individuals could be selected having almost any qualities of either parent combined in almost all possible proportions, and often greatly intensified.

This was, as we now know, substantially the discovery that Mendel had made almost twenty years before. But no one heard of his discovery till long afterward (about 1900), and at about the time when I was independently learning the same lesson Mendel himself died, quite unknown to fame, without having been able to bring his discovery to the attention of the scientific world.

Meantime, without formulating the principle in precise terms as Mendel had done, and without following up results with numerical exactness, I came to full recognition of the principle of blending of characters in the first filial generation and their reassortment and segregation in the second and succeeding generations.

All my experimental work was carried forward with a clear recognition of that principle.

As to the work with the raspberries, my first aim was to accumulate as much available material as possible.

This has been my custom throughout. The chances of obtaining results from a large number of experiments are proportionately greater as the number increases, and I find, within limits of time, that it is just as simple to conduct a thousand or ten thousand experiments, or even a hundred thousand experiments, as to conduct a few.

So I worked on a comprehensive scale with the raspberries from the outset; and it was not long before several varieties of value were developed; varieties, in fact, superior in size, quality, and productiveness to any raspberries hitherto known.

First Fruits of the Experiments

The first of my new raspberries offered to the public was named the Eureka.

This raspberry, introduced in 1893, was described as "larger than any raspberry in cultivation; bright red, firm, very productive, and similar to Shaffer's Colossal in its piquant acid flavor. It is nearly twice as large as Shaffer's Colossal,

its great-grandparent, and a better color and quality, firmer, handsomer, and in all respects an improvement on that well-known variety. The bushes are more compact in growth, almost free from prickles, and of a sturdy appearance."

Particular attention should be called to the fact, just stated, that the new raspberry was almost thornless. This was true of a number of my raspberries, as by selective breeding I was able to give these vines smooth stems at a time when my similar attempts to remove the thorns from the blackberry had not been successful.

The difference was due, perhaps, to the fact that the raspberry, having been long under cultivation, had partly lost its thorns through more or less unconscious selection on the part of many generations of fruit growers. The thorns had been reduced in many varieties to prickles, and occasionally individual specimens appeared that lacked even these. By selective breeding from such specimens I was able to produce varieties that had practically smooth vines.

A selected seedling of the Eureka was remarkable for its habit of bearing in October as well as for the enormous size of the berries, which were frequently almost four inches in circumference. The berries were of a beautiful bright

THE PRIMUS BERRY

This highly interesting plant is one of the first that could properly be termed a new species developed under the direct guidance of the hand of the experimenter. It is the progeny of the California dewberry and a hardy little berry indigenous to Siberia and Russia, called the Siberian raspberry. The remarkable Primus berry appeared as a first generation hybrid, and it always breeds true, having the characteristics of a new and permanent species.

red, but were rather too soft except for home use.

Another of my crossbred raspberries, originated at the same time with the Eureka, was called the Dictator. This also is a mammoth bright red berry. It combines the flavors of the Gregg and Shaffer's Colossal from which it originated. The combination is one of the happiest, as the acidity of one is modified by the sweetness and aroma of the other. The berries were more than three times as large as those of the Gregg, and almost twice as large as those of Shaffer's Colossal, which until the production of these new hybrids bore the largest raspberries known.

Another cross of the Gregg, this time with the Souhegan, produced a seedling that had astonishing crops of fine, medium-sized, red berries that ripened during October. The Souhegan was also crossed with the Shaffer, and this union produced in the second generation a new variety that was known as the Sugar.

From the seeds of other members of this same generation two or three other promising berries were produced. One of these bore large, firm berries, conical-shaped, and a dark, rich purple color; some of these proved too tender for the colder States; some were renamed and others now supersede.

A New Species—The Primus Berry

All the raspberries commonly known to the cultivator, and many new ones that I imported from Asia and the Southern Hemisphere, were growing on my grounds from 1890 to 1900, and were intercrossed very extensively. Numbers of highly interesting hybrids were thus produced, and at least one of these was of so distinctive a character as to merit the title of a new species.

This was the fruit that was introduced as the Primus berry.

This highly interesting fruit, probably the first plant of any kind that could properly be termed a new species to be developed under the direct guidance of the hand of the experimenter, was the progeny of a hardy little berry indigenous to Siberia and Russia, called the Siberian raspberry (*Rubus cratægifolius*), and the California dewberry.

The little hardy Northern raspberry bore fruit about the size of a pea, of a dark mulberry color, with rather large seeds, and a flavor not such as particularly to commend it. It is, however, remarkable for its large palmate leaves, and the sturdy growth of its stems.

The California dewberry, *Rubus vitifolius,* is a trailing vine which is extremely variable in fo-

liage, habit of growth, size, and quality of fruit. It is found wild everywhere in the foothills and lower elevations throughout the Pacific slope of the United States, but seems to be at its best in northern California and Oregon. The berries of this wild species are often produced abundantly. They are black, usually of good size, though rather soft, and of superior quality. They are often gathered in large quantities for market and home use.

The fact that this species bears diœcious flowers—that is, flowers of opposite sexes on separate plants—has discouraged a very general cultivation of the plant. It is necessary to grow both male and female plants to insure fertilization, and fruit growers do not relish the idea of having half their vines unfruitful.

Nevertheless, there was one variety of the California dewberry, called the Aughinbaugh, which had been under cultivation for several years. This was the one selected for most of my experiments in hybridizing the dewberry; and this plant had a share in the production not only of the Primus berry, but of the even more remarkable Phenomenal berry to which reference will be made in a moment.

The cross between the Siberian raspberry and the California dewberry, from which the Primus

sprang, was made without particular difficulty. I had learned by this time that blackberries and raspberries and dewberries could be hybridized almost indiscriminately; and the fact that one of the parents in the present combination had grown originally in Siberia and the other in California offered no barrier to the union.

With the first lot of seedlings, five hundred or more, from this union of the California dewberry and the Siberian raspberry, some strange specimens were revealed.

Nearly all were worthless plants, some of which seemed hardly to have vitality enough to live, much less to produce fruit. Others bore small, unattractive berries, insignificant in every respect. Three or four individuals, however, grew with unusual vigor. They differed so widely from the others that I was at first inclined to suspect that they were dewberries unhybridized. As to this, however, the result proved that I was in error.

One of these exceptional vines was particularly notable. It neither trailed nor stood upright, but took an intermediate position. The leaves were not palmate like those of the raspberry, nor were they like the foliage of the dewberry. They were a compromise between the two.

The fruit, which was larger than that of either parent, resembled the blackberry most in form, but was of a dark mulberry color.

When the fruit was just ripe it parted from the stem like the blackberry; but when fully mature the core came out as it does in the raspberry.

Thus the combination of all these important characteristics was almost absolutely complete. The hybrid was a perfect blend.

It was this plant that was christened the Primus berry.

Seedlings by the thousand (5,000 one season) were raised from this selected hybrid and all of them came as true as the seeds of any wild species of the family. The offspring closely resembled the Primus, but none of them quite equaled it in fruiting qualities.

If found growing wild, the original Primus plant and its progeny would be pronounced by any botanist a distinct species.

The explanation of the summary production of a hybrid differing in this remarkable manner from either parent and being so fixed in type as to breed true to the new form thus suddenly developed would seem to be that the two parent species were separated almost to the limits of affinity. The fact that most of the hybrids of the same generation with the Primus were feeble and

degenerate creatures is corroborative. It appeared, however, that there were elements in the two types of germ plasm that if combined in just the right way would produce a virile offspring.

By chance the right combination was effected, and the Primus berry was the result.

The berry itself has not proved a great commercial success, but that is a matter of small importance. The real importance of the experiment was in what it proved as to the possibility of the production of new species through hybridization. This was, in short, one of the first instances to come under my observation of the production of a hybrid that blends the characteristics of the parents, producing a new type and breeding true to that type.

To my mind—and I think the facts are convincing to any unprejudiced mind—this and many similar experiments that have been successfully accomplished demonstrates beyond dispute that hybridization is one of nature's methods of creating new species.

As this subject has been dwelt upon at length in earlier chapters, I revert to it here because of the importance of the subject itself, and also because the Primus berry furnishes us a new and striking illustration of the truth of the principle.

Of course, the Primus berry was produced by artificial pollenizing of the plants that were so located geographically that they would have had no chance to hybridize unless brought together by man. But my observations show that natural hybrids are not at all unusual among wild members of this family. I have met with them often where two or three closely related species were growing side by side.

Near Lake Sycamore, for example, in Alberta, Canada, I have observed two common raspberries, *Rubus strigosus,* a red raspberry, and *Rubus leucodermis,* a blackcap, growing in close proximity around the hillsides and along the streams.

In every case where I found these two species growing together there were numerous natural hybrids in evidence. None of these hybrids were as productive as the parents, but the vines were usually stronger growers than either, and appeared to be hard pressing both parent species, with the prospect that they would in time supplant them in this region. I gathered large quantities of seeds from the best of these hybrids and brought them home for planting. Many seedlings were thus raised which obviously carried the combined characters of both their wild parents.

THE PHENOMENAL BERRY

The color print shows this remarkable berry much reduced in size. Many of the berries are an inch and a half long and an inch in diameter. In flavor the Phenomenal berry combines the qualities of raspberry and blackberry, both flavors seeming to be intensified. Its individual qualities are so marked and distinctive that it is entitled to be designated a new species.

These representatives of a new species developed by hybridization under natural conditions have obvious scientific interest even though they failed to develop sufficient productivity to be of commercial value.

Let me repeat that natural hybrids are much more numerous than is generally supposed.

I have found them among other wild plants. Especially are they to be observed among strawberries, blueberries, huckleberries, and California lilacs (*Ceanothus*). I have elsewhere cited instances of the hybridization of the tarweeds and the mints. There can be no doubt that some of our well-known species of to-day were produced by nature in this way within recent times.

I have elsewhere observed, and I emphatically repeat, that any theory of the origin of species that does not recognize this among the methods employed by nature for the production of new species is altogether inadequate.

Another New Species—The Phenomenal Berry

The result of thus mating the dewberry with the little raspberry from an almost arctic climate having proved so remarkable, almost numberless tests were made in which the dew-

berry was crossed with a great variety of other raspberries and blackberries.

And among the hybrids thus produced there was at least one that might be considered more remarkable even than the Primus berry.

This was the fruit which afterward became famous as the Phenomenal berry.

This extraordinary berry was the outcome of a series of experiments in which the red and yellow raspberries were variously combined with the dewberry.

In the first generation of these hybrids, numerous red berries and black berries were produced, but no yellow ones. A large proportion of the red varieties followed the raspberry in general characteristics except in form, but some of them acquired the high flavor of the dewberry combined with the aroma of the raspberry.

Most of the seedlings of this first generation resembled the wild dewberry in habit of trailing along the ground. Yet there were some that favored the raspberry, standing upright. In flavor many were a good combination of the two parents, but the variation was not pronounced in this respect. Some were highly flavored while others were quite insipid, and between the two were all gradations. Variations in size and shape were equally marked.

Most of these seedlings were quite productive, but no one plant was sufficiently valuable to warrant its introduction as a new variety worthy of cultivation.

Berries were gathered, however, from the most promising of the dewberry-raspberry hybrids. Among the second-generation seedlings thus produced was one that was of different caliber from all the rest as shown by the character of its fruit.

No such berries were perhaps ever seen before as those that grew on this second-generation offspring of the Cuthbert raspberry and the California dewberry.

Some of the berries were an inch and a half long and an inch in diameter. They were a dark rich crimson color, slightly downy, and glossy. In flavor they combined the qualities of raspberry and blackberry, both flavors seeming to be intensified. In a word, the fruit was a blend between the fruits of the parent races. It was a new variety so markedly distinct from either parent as to justify the designation of a new species.

The new berry was originally called the Humboldt, but was subsequently rechristened the Phenomenal by the purchaser.

The new fruit was not altogether unlike the loganberry, which was an accidental hybrid dis-

covered by Judge J. H. Logan on his place near Santa Cruz, which was believed to be a hybrid between the red raspberry and the California dewberry. But the Phenomenal is far superior in size, quality, color, and productivity, and it is gradually displacing the loganberry.

Unfortunately the two are sometimes confounded, and unscrupulous dealers have been known to sell the loganberry under the name Phenomenal.

The new fruit, like most other plant developments—the Burbank plum, the Wickson plum, and the Pineapple quince, for example—was not fully appreciated for about ten years. But it is now a standard berry on the Pacific Coast, and as far as possible it is being introduced in other regions wherever it will thrive. As already noted, it is probably the largest of all known berries. As a fruit for market or home use for drying and canning it is of the first importance.

From the standpoint of the plant developer the Phenomenal is of additional interest because of its almost exact combination or blend of the qualities of its parents.

I have raised numerous seedlings from the Phenomenal, but up to the present have found none that quite equals it in all its excellent qualities, though, like the Primus, it is a fixed new

species, the seedlings not reverting to either parent form. The new berry has also been used as seed parent in a number of crosses with other blackberries and raspberries, and some thousands of seedlings thus produced are now under observation.

Among these hybrids great variations will, of course, occur, and while nearly all will undoubtedly be of inferior quality, I have confidently expected to find at least one that surpasses even the Phenomenal; and now this expectation has been fully realized in a new very sweet variety which will later be introduced.

Other Perfectly Balanced Hybrids

Hybridizing experiments of almost equal interest, even if not quite so striking in results, have been made between the various raspberries and the Lawton blackberry.

The Lawton is a very prepotent parent in these crosses, and its characteristics will almost invariably be found to predominate. Even the pollen of the Lawton when applied to the raspberry more often produces the Lawton type of berry than any other type. But in exceptional instances I have produced Lawton hybrids in which the prepotency was not so strongly manifested.

AN INTERESTING HYBRID

The fruit here shown is a cross between the yellow Golden Queen raspberry and the Lawton blackberry. It possesses qualities of both blackberry and raspberry. When blackberry-raspberry hybrids are picked, it is not unusual for them to bring away the receptacle with the fruit, like a blackberry, if they are not quite ripe; and to leave the receptacle, like a raspberry, if entirely ripe. Few experiments have greater scientific interest than those in which the raspberry and blackberry have been hybridized.

Such was the case, for example, with a cross between a yellow raspberry known as the Golden Queen and the Lawton. This produced a hybrid so well balanced that no one who saw it could tell whether it was a raspberry or a blackberry.

Numerous seedlings of this hybrid strain were raised, and in the second generation the qualities of the hybrid were reproduced, as in the case of the Primus berry and the Phenomenal. No variation occurred such as is usual in the second generation of most hybrid blackberries and raspberries.

The bushes had prickles that were short and stout instead of long and slender as in the raspberry. The leaves also had the rough, ribbed appearance of the blackberry.

The berries would cling to the receptacle (a blackberry trait), or part from it (a raspberry trait), according to ripeness. As to color, there were both red and yellow varieties among the hybrid plants. The flavor of the berries was not exceptional, but in some other similar crosses made at a later period the fruit was in some cases greatly superior in quality to that of either of the parents.

Still greater interest attaches, perhaps, to a hybridizing experiment in which the parents were

Shaffer's Colossal raspberry and the Crystal White blackberry.

Some of the plants from this cross were of the most treelike proportions. Most of them, however, were barren, though they bloomed freely. But there were exceptional ones that fruited, and selected seedlings were grown from these through a series of generations. In the fourth generation a plant appeared which was of such extraordinary characteristics that it was given the name of Paradox.

This plant was in all respects a most perfect combination of the two ancestral forms from which it sprang. The wood, bark, leaves, blossoms, prickles, roots, and seeds could not by any test be proved to be like one or the other. The fruit, produced in abundance, was an oval, light red berry of good size, larger than that of either progenitor, and of fair quality.

Many of the first generation descendants of the Paradox were partially barren, though blooming freely. Sterility as to fruit was often associated with gigantic growth.

But some of the seedlings were fertile, and they manifested almost every possible combination of qualities of the raspberry and blackberry. Some were similar to the Paradox, except that they had white berries instead of red.

By saving seeds from the white and the red varieties separately, I found that they bred true, each constituting practically a fixed species.

As to the vines themselves, there is very little variation, the canes and foliage presenting an exact balance between the raspberry and the blackberry.

The berries are not of great commercial value, as the fruit, though large, is soft. I hope, however, to harden the berry by selective breeding, and introduce a better flavor.

Although this hybrid progeny of raspberry and white blackberry may ultimately have commercial importance, it is chiefly prized for the scientific significance of its revelations.

Descended as it is from a cross between the raspberry and the blackberry, it constitutes a fixed species differing radically from every other *Rubus* known.

So in this regard the Paradox takes its place besides the Primus and the Phenomenal berries as offering an impressive object lesson in the production of new species by hybridization. Let it be recalled, however, that the Primus was a first generation hybrid, whereas the Phenomenal appeared in the second generation, and the Paradox in the fourth.

There has been occasion in an earlier chapter to tell of hybridizing experiments in some respects even more curious, in which the raspberry was fertilized with pollen of the strawberry. These experiments will be further examined in a later chapter, with reference to the interpretation of the observed phenomena of hybridization of the various brambles.

But perhaps no comment could greatly add to the impressiveness of the simple recital of facts as to the production of new forms that, according to all botanical standards, rank as distinct fixed species, through the purposeful blending, under the hand of the plant developer, of the germinal strains of the various blackberries and raspberries.

The chances of obtaining results in plant improvement are directly proportionate to the number of experiments tried; and a hundred thousand experiments may be conducted as simply as a few.

DESIGNING A STRAWBERRY TO BEAR THE YEAR AROUND

And Other Work with Strawberries

A PLANT enthusiast was explaining the functions of plant life one day to that most appreciative and stimulative of all audiences, a company of school children.

He had told of the supreme importance of the *seed*—how nature must first and foremost think of that, because it is the link between successive generations of plants; the only means of assuring a continuance of the race. To bring the illustration home, he had said that the seed is the very heart of the plant.

A little miss who had absorbed every word with the eager receptivity of the child mind looked up quickly as he finished and said:

"Then the strawberry is a plant that wears its heart on its sleeve, isn't it?"

It is only the imagination of children—or of the chance individual here and there who remains

a child all his life and whom therefore we term a poet—that can sound the depths of a great subject with a single phrase like that.

"The plant with its heart on its sleeve."

That is the strawberry. Cowering, timid, nestling among the grasses, seeking obscure corners, retiring as far as it may from observation—and wearing its heart on its sleeve!

The strawberry, it must be recalled, is own cousin to the peach and plum, the apple and pear, the rose, the blackberry, and the raspberry. But where these raise their heads into the air and hold out their flowers and fruit to the inspection of all the world, the strawberry has taken to earth and become a creeper.

Yet whereas the other fruits shield their seed always with pulp of the fruit, and some of them even inclose it also in armor plate shells, the strawberry puts its seed on the very outside of the fruit, where they will inevitably be eaten by any bird that so much as pecks at the fruit itself.

Hence the pertinency of the little girl's characterization.

The Odd Custom Explained

But, of course, there must be an adequate reason for the curious conduct of the strawberry. A plant does not depart from the traditions of

its ancestors and take on new and strange customs unless it finds advantage in so doing. The case of the strawberry is no exception. That this plant is admirably adapted to its environment, and for that matter to environment of great diversity, is shown by the fact that strawberries of one species or another grow in regions as widely separated as Patagonia and Norway and Alaska.

And that the anomalous character of its fruit has very distinct advantages is evidenced by the fact that in all the diversified regions in which it grows the strawberry holds to precisely the same architectural scheme in the building of its fruit.

The leaves and stems and manner of growth of the different species may vary considerably, although even here there is no very wide diversity. But as to fruit, every strawberry of whatever species may be instantly recognized as a strawberry by the most casual observer. You may never have seen the species before, but you could not possibly mistake the fruit for the fruit of any other tribe of plants.

A pulpy berry with tiny seeds sprinkled over it and only half imbedded in the pulp, like seed on the frosting of a cake, is a strawberry and nothing else.

A SAMPLE SEEDLING STRAWBERRY

I have experimented very extensively with strawberries, and this specimen is a fair example of the results which may be expected from seed of the best varieties.

Almost every other fruit has counterparts that suggest close relationship. Peaches and nectarines, apricots and plums, apples and quinces, oranges and grapefruit, lemons and limes, blackberries and raspberries, watermelons and muskmelons—these and sundry other fruits seem to go in pairs, as it were. They show the result of nature's constant tendency to experiment and to find new ways of doing the same thing, each method reasonably well adapted to its purpose.

But when the scheme of the strawberry had been perfected, it would seem that it must have proved so very admirable that there was little chance to improve upon it and no occasion to vary from it. Hence strawberries are quite in a class by themselves from the botanical standpoint, just as they are from the gastronomic standpoint.

In admitting this, it does not follow that we must agree with the enthusiast who declared, not long ago, that the strawberry is the one fruit that is past all improvement.

We shall urge in a moment that there is still very much to do before the strawberry can be considered a really perfect fruit from the standpoint of the consumer. It can be made, and should be made, to give up its seeds altogether, for example.

Now that it has come under man's protection, it does not need the seeds, any more than the pineapple and the banana need them.

Aforetime it placed the seeds on the very outside, where they would necessarily be eaten by any bird or animal that tasted the fruit, because it was imperative that the seeds should find means of transportation in order that the race of strawberries might spread and inhabit the earth.

The plant that cowers close to the ground cannot depend in the least degree on the wind or any other inanimate agency to transport its seeds. It must look to birds and animals to aid in this direction.

So the strawberry sprinkled its seeds on the outside of the fruit, having first taken the precaution to cover the inconspicuous seeds themselves with an altogether indigestible shell of cellulose. The subterfuge served the little plant extremely well, as its wide range of wanderings and secure foothold in diverse soils and varied climates sufficiently attests.

The Seeds No Longer Needed

But now, as was said, this expedient is no longer necessary. Men will take good pains to see that the strawberry is abundantly propagated. And as such propagation may most

advantageously be made through the agency of roots and runners rather than with the seed, there is no longer any necessity whatever that the seed should be retained. There are a good many scores of them on a single fruit; and the draft on the energies of the plant required to produce this large quantity of concentrated germinated matter must be very marked.

So when the strawberry has been induced to give up the seed-producing habit altogether, devoting its fruit energy to the production of the juicy pulp of its unique product, the plant itself will advantage by the change, while at the same time gaining added favor with the fruit lover.

Nothing has hitherto been done toward relieving the strawberry of its seeds, because hitherto the plant developer has been more concerned to increase the fruit itself and has given small thought to the seeds or has ignored them altogether.

But the briefest inspection of different strawberries will show that they differ a good deal as to relative abundance of seed; and there is no reason to doubt that the plant developer who undertakes this selective breeding with an eye to the preservation of plants that show a tendency to minimize the seed product, will gradually develop a race of seedless strawberries.

It appears to be quite the rule that plants habitually propagated by root division or by rooting stalks or runners tend to lose their power of seed production when long thus cultivated. The pineapple, the banana, the sugar cane, the horseradish, and the potato, have been previously referred to in this connection.

All of these, as is well known, are propagated by the cultivator without the use of seed, and it is only under the most unusual conditions that any one of them nowadays produces seed at all.

I took occasion to emphasize this fact once in a lecture by saying that I would very willingly pay a thousand dollars an ounce for horseradish seed. The joke went the rounds of the papers and hundreds of people all over the country watched their horseradish plants the ensuing season with an idea to gaining the prize.

Needless to say no one has yet produced the ounce of seeds, or any fraction thereof.

Of course there are certain disadvantages that will attend the entire giving up of the habit of seed production.

It is not that the plant propagated exclusively from the roots, buds, grafts, or cuttings degenerates, as was once thought to be the case. In reality there seems to be no limit to the number of generations through which a plant thus propa-

gated by division may maintain its original standards of quality. The familiar cases of the orchard fruits sufficiently support this belief. It may even be possible to improve a plant slightly by selection when propagated solely in this way.

But, on the other hand, it is obvious that the plant that gives up the habit of seed production renounces the possibility of benefiting by the introduction of new strains through hybridizing—a process, as we have all along seen, that is the principal means through which plant evolution is brought about.

So, as regards the strawberry, it will be desirable to make sure that we have developed fruits to approximate perfection before we induce it to give up the habit of seed production altogether.

It can hardly be claimed that the strawberry has reached this stage of development, notwithstanding the verdict of the enthusiast already quoted. But, on the other hand, it must be admitted that the best varieties of fruit approach an ideal standard rather closely. And when we recall that the development of these almost perfect varieties has taken place rapidly and within comparatively recent times, it seems a fair conclusion that it will be possible to complete the perfection of the fruit in other directions in less time than it will take to remove the seeds.

AN ALL-SUMMER BEARER

One of the new strawberries which blossoms and bears all summer. This tendency to bear continuously possibly results from the blending of the heredities of species from the Northern and Southern Hemispheres. (About one-third life size.)

So the plant experimenter who would undertake the task of eliminating the seeds from the strawberry need not hesitate for fear of succeeding too soon. Unless nature should produce a chance sport that is without seeds, or nearly so, somewhat like the nearly stoneless plum, the task of removing the seeds of the strawberry by mere selection would prove an arduous one.

Yet it can doubtless be accomplished; and the game is thoroughly worth the candle.

Origin of the Cultivated Strawberry

Partly because all strawberries are so much alike, it has been unusually difficult to trace the origin of this fruit. But it is known that the modern varieties have been developed in a period of not more than two centuries.

The strawberry has indeed been under cultivation for an indefinite period. But the ancients were doubtless content, as we know that the moderns were until a few generations ago, with a small berry scarcely superior to the ones that grow wild in many regions of America. The systematic cultivation of the fruit began in England after new species of strawberry were introduced from North and South America.

But the really notable progress did not take place until the South American species known

as *Fragaria Chiloensis* was introduced early in the eighteenth century from Chile.

Nor indeed was there any immediate improvement from the introduction of this fruit. But about the year 1760 a new variety suddenly appeared that was called the Pine strawberry because its fragrance suggested that of the pineapple. There was no record as to its origin, but the best authorities argue with good reason that it was a hybrid between the Chilean strawberry and the American species introduced much earlier from Virginia.

As usually happens when different species are hybridized, a tendency to variation was produced, and before the close of the eighteenth century there were two important types of new strawberry of the Pine variety, one of which was named by the botanist *Fragaria ananassa* and the other *Fragaria grandiflora.*

It is argued with plausibility that these are modified forms of the South American strawberry introduced from Chile, the precise share of other species in the combination not being perhaps clearly established.

The most popular modern varieties of strawberries are the descendants of this so-called Pine stock, the most notable impulse to the development of new varieties having been given through

the introduction of Keen's seedling in England in 1821 and Hovey's seedling in America in 1837.

Subsequent development has come about through the usual method of crossing and selection. Of course, many varieties, differing in such minor details as the production of runners, resistance to fungus attacks, and precise qualities of the fruit have been devolepd. Different races also show a diversity as to manner of flowering, certain varieties bearing pistillate flowers, just as the California dewberry does, whereas others bear perfect or bisexual flowers, as is customary with the members of the rose family in general.

But these are minor differences; and, as we have seen, the strawberry type in all its essentials has been marvelously maintained from first to last. Now as always this fruit is unique and curiously isolated.

Hybridizing Experiments

My own experiments with the strawberry have been carried out on rather expansive scale, although I have given by no means as much attention to this fruit as to many others.

I have crossed all the familiar cultivated varieties, and in addition have made hybridizing ex-

EVERBEARING STRAWBERRIES

The strawberry has been under cultivation for an indefinite period, but it is only in comparatively modern times that any such berries as those here shown have been grown. The ancients were doubtless content, and the moderns were also, until a few generations ago, with a small berry not greatly superior to the ones that grow wild in many regions of America. The ever-bearing strawberries are a new production. (One-half life size.)

periments in which numerous wild species, some of them imported from distant regions, have had a share. I have, for example, commingled the strains of the best varieties of the cultivated strawberry with those of strawberries from Norway and from Alaska, and the native Chilean species, as well as with various wild species of our own.

I have also attempted to hybridize a species from India, the *Fragaria indica,* with other strawberries, but have been unsuccessful. It does not by any means follow that this cross cannot be effected. But it is perhaps not worth while to devote an undue amount of time to the experiment, as the qualities of the Indian species are not such as make it certain a hybrid thus produced would have any value, except possibly as introducing a tendency to variation.

The Indian plant bears a small, insipid berry, and is cultivated for ornamental purposes only.

There are various wild strawberries growing along the Pacific Coast that offer interesting possibilities of hybridization. It is rather interesting to know that some of these are of the same type with the Chilean species that has already been named as the chief progenitor of the cultivated strawberry.

One of these, known as the sand strawberry, is quite common along the coast, especially in the northern part of California.

This is a plant with large, woolly leaves. It is greatly inclined to produce runners. It fruits sparingly, but the berries themselves are sweet and of fine flavor. There is great variation as to foliage and flowers, as well as in capacity for fruit production.

The variation is best explained by assuming that this strawberry is itself a natural hybrid.

Another California strawberry that has interest is the wood strawberry, *Fragaria californica,* a plant that usually has small leaves, rather upright in growth, and producing fruit abundantly, though the fruit itself is insipid and hardly worth gathering.

This plant also varies widely in different localities. In the Yosemite Valley I found a most astonishing variation in these as well as in other strawberries. Some of the wild varieties growing there were fully equal to the cultivated strawberry, while others were insignificant to the last degree.

Some of the plants grew strictly upright; others had leaves that hugged the ground and spread in all directions. There was a wide range of variation as to form, size, foliage, and fruit.

This was quite the most interesting group of wild strawberries that I have come across anywhere. But these plants do not seem to thrive in the valleys as they do in their mountain home.

As to the latter point, there is a striking propensity on the part of certain strawberries to degenerate when placed under changed conditions of soil and climate.

We have seen that plums and many other plants are stimulated to exceptional growth by precisely such a change. But when the most promising wildlings from the Yosemite were transplanted to my gardens they ran to vines and produced very little fruit, although in their native habitat they had borne abundantly.

The experience was precisely the same with certain strawberries that were sent from Alaska and from Norway, and in many of those from Chile. When the Alaskan vines came to me, through the kindness of the captain of an Alaskan steamer, they were in full bloom and later supported an abundance of splendid berries. But under cultivation in my grounds they failed to produce fruit, but persisted in making runners only. The new soil and climate which had proved such a stimulus to Japanese plums and New Zealand rhubarb and European daisies, and almost countless others, proved a

ANOTHER PERPETUAL VARIETY

In form and color these berries resemble pretty closely those shown in the preceding plate. They differ markedly, however, in flavor. Like the others, they are of mixed ancestry, blending the strains of berries from two hemispheres. This variety bears luscious fruits all summer, and all winter, too, in a greenhouse. (One-half life size.)

handicap to the Alaskan strawberries. The new environment was not adapted to their constitution.

I have often had the same experience with other plants, including certain varieties of currants, blueberries, huckleberries, and raspberries, as well as maples, beeches, hickories, and other trees and plants from the eastern United States, Canada, Alaska, and other northern climates.

New Hybrid Varieties

But, of course, there are many other species and varieties that have shown no such antipathy to the conditions we had to offer, and I have produced large numbers of crossbred strawberries from various importations that have prospered.

In the course of the past forty years I have probably grown and fruited strawberry seedlings to the number of more than half a million; and among these have appeared some varieties that have had qualities of a high order, yet among them all I have not until somewhat recently secured one that was thought in all respects superior to some existing variety. Therefore, none of these were introduced. Ten or twelve years ago I had one that was nearly perfect but which proved to be a poor keeper and therefore not suitable for the market.

But more recently, as the strawberry strains became blended, varieties have been produced which not only excel in quality but also have the highly desirable characteristic of persistent bearing.

The new strawberry has been developed through hybridizing stock that had among its ancestors such well known varieties as Longworth's Prolific, Brandywine, Monarch, and the Arizona Everbearing, and one or two varieties from Texas.

The later hybridizations, through which the perfected strawberries were finally secured, have involved crossing the Chilean strawberry with the small wild white strawberry from Virginia and with the wild Pacific Coast strawberries.

From these two lines of hybrids I have obtained the only seedlings that have been thought worthy of introduction.

The paragon of these is a plant of vigorous growth which makes just the right number of runners, and which has a healthy, thick, dark green foliage. The fruit is borne in clusters well up from the ground, and is delicious in quality, I confidently believe, beyond any strawberry before known.

This has been the universal verdict of those who have tasted the fruit of this complex hybrid

When John Burroughs visited my farms, for example, he unhesitatingly pronounced this strawberry the finest in the world. So great was his enthusiasm that he wrote to eastern seedsmen, advising them to secure this strawberry, as everyone would soon be wanting it.

The fruit of this hybrid is not extraordinarily large, but it is firm in texture, of a fine crimson, and unlike most other strawberries it has a yellow flesh. Its lusciousness and deliciousness of flavor will give it a place apart even among the most select varieties of the fruit.

But quality of the fruit is not the only merit of the new hybrid. The plant has also, as just intimated, the singular and important quality of bearing fruit throughout the whole summer.

The main crop comes at the usual time for strawberry ripening, but berries continue to ripen, even if less profusely, month after month, until the frosts of winter arrive.

Doubtless this habit of perpetual bearing is a trait brought out by the mingling of so many racial strains; in particular by the union of races from the two hemispheres. The summer of Chile is of course our winter. I have several times adverted to the confusion that seems to overtake many plants when brought to our northern latitudes from the Southern Hemisphere.

YET ANOTHER HYBRID VARIETY

Were it not for the marked difference in the leaves, one might think this bunch of berries of the same variety as the ones shown on the preceding plate. They are, however, very different, although of the same ancestral strain. They represent the segregation of characters in later generations, of which we have seen so many illustrations. But with the strawberry, the characters referred to concern the texture and flavor rather than form and exterior color. (One-half life size.)

The case of some of the New Zealand apples, which were confused as to time of bearing for two or three years after being imported, will be recalled.

Also in the case of the winter rhubarb, which came to be a perpetual bearer partly perhaps through the influence of such transplantation.

The new hybrid strawberry, which combines ancestral strains from the two hemispheres, furnishes another illustration of the tendency to retain ancestral habits as to time of fruiting, and thus, where parents from both hemispheres are involved, to develop among some of their seedlings a new habit of perpetual bearing.

It will probably be possible, by further selection from the new race of all-the-summer-bearing strawberries, to extend their time of fruiting, as was done with the winter rhubarb, until they bear throughout the year in any climate where the winters are sufficiently mild

New Varieties in the Making

Other novelties that have developed among the progeny of the company of widely hybridized strawberries include constant producers and enormous producers that as yet lack

some other quality which will presently be supplied.

I have also a white strawberry, grown from a variety that I grew in my childhood back in Massachusetts, and which was said to have come from Virginia.

By hybridizing this species a few promising white strawberries have been produced with new and delicious flavors. Second generation seedlings in great numbers are being raised, and interesting results are sure to be attained in the near future.

This strawberry stock, like my stock of plums and some other fruits, now consists of complex hybrids from which almost anything may be expected. At least it is certain that new combinations of qualities, within the extreme range of strawberry variation, will appear among the seedlings of these conglomerate yet carefully nurtured and selected stocks.

Summarizing my work on this fruit, I would say that selections have been made primarily for flavor rather than for size and color. I thought that a good home strawberry that is tender, sweet, and of fair size rather than of exaggerated proportions, combining these qualities with the exquisite flavor of some of the wild berries, would be a distinct acquisition.

The varieties already in the market were many of them of enormous size, but for the most part they lack flavor.

Anyone who has known the small wild strawberry at its best must always experience a certain disappointment in eating the cultivated varieties.

Moreover, most of our market strawberries are hard, being judged by the growers and the dealers by their shipping quality rather than by their flavor.

It seemed desirable, particularly for home use, to develop the strawberry for its appeal to the palate as well as to the eye; in other words, to restore to the fruit something of its pristine flavor, while retaining the good qualities introduced in recent times by selective breeding.

Such an endeavor to improve the flavor of the fruit, combined with the idea of all-the-year bearing and ultimately of seedlessness, may be said to suggest the lines of improvement along which the plant developer of the immediate future should work in perfecting the strawberry. But the production of the seedless strawberry, as already pointed out, must be the final stage of the process of development. When the seeds are gone, there will obviously be no further

opportunity for improvement by selective breeding, with or without hybridization. But long before the seeds are bred out, we shall doubtless have many varieties of strawberries that approach perfection as to all other desirable qualities.

Nature has done much for the luscious strawberry, but there is still as much or more for us to do.

THE SUNBERRY—A PRODUCTION FROM THE WILD

A New Food Plant from the Potato Family

SUPPOSE that you had been trying for twenty-five years to effect a certain purpose—say the cross-pollenizing of a particular pair of species of plant.

Suppose that year by year your efforts had met with total failure; but that finally, just as you were on the point of giving the matter up as hopeless, you were to attain success.

Doubtless under these circumstances you would be somewhat elated over your achievement, the result of so much effort.

Suppose, then, further, that the plant that grew from this hybridization, achieved with such infinite difficulty, proved a producer of a valuable new fruit. Suppose that the fruit met with almost immediate recognition, and that the plant was widely introduced and attained exceptional popularity.

And then, finally, suppose that some one should come along and decry the fruit, not because of its lack of merit, but because the parent plants from which the hybrids grew belonged to a family of poisonous plants.

Suppose the hue and cry thus raised should be given an element of plausibility by the fact that some unscrupulous person had sold to gardeners a plant of a different species from either of the parents of your hybrid, yet of an allied race, and had claimed that this plant, which bears a fruit of doubtful edibility, is identical with the one you had introduced.

Suppose all this, I say, and then try to imagine just what would be your attitude of mind toward the work you had accomplished on one hand, and the persons who—not always for the best motives or without prejudice—were its traducers.

The Sunberry and Its Critics

In suggesting this I am only asking you to put yourself in my place and imagine what must be my natural attitude of mind toward one of the most celebrated, and without doubt the most berated, of all my plant productions—the fruit which I named the Sunberry, and which the dealer to whom I sold it rechristened—without

my consent and much against my wishes—the "Wonderberry."

For the supposititious case that I have just outlined really summarizes the facts as to the production and introduction and traduction of that fruit.

The Sunberry, far from being merely a familiar form of *Solanum* introduced under a new name, as some ignorant and misguided critics have alleged, is in reality the product of one of the longest and most persistent series of experimental hybridizations, culminating in the blending of two specific plant strains that had seemed to be antagonistic beyond the possibility of amalgamation.

The parent plants themselves, though they no doubt belonged to a poison-bearing family, like the egg plant, tomato, pepper, were not in themselves poisonous. And the fruit of their hybrid progeny is not only palatable in high degree, but altogether wholesome, as thousands who have eaten it habitually could testify.

Let me quote a paragraph from a letter recently received, by way of substantiation, and then let me turn from this controversial aspect of the subject to consider the story of the Sunberry itself:

SUNBERRIES

This is in some respects one of the most remarkable, and unquestionably the most maligned, of fruits. It resulted from a hybridization of two Solanums effected after years of unsuccessful efforts. It was named "Sunberry," but was subsequently rechristened the "Wonderberry," quite against my will, by the dealer who purchased and introduced it. It has been fiercely assailed, largely because it was foolishly confounded with a quite different species of Solanum; notwithstanding which it has made its way in the fruit garden, and is destined to be far more popular than ever, and is now grown everywhere. (One-half life size.)

"I have grown the Sunberry for the past three years," says a college professor who is an amateur gardener. "We have used the berries for sauce, cobbler, and pies—principally for pies. Some were eaten raw from the vines. For me the pie is the one great way to use the berry. Without exception I place a Sunberry pie at the head of the pie list, and I do this with a full appreciation of the excellence of cherry pie, apple pie, pumpkin pie, mince pie, blueberry pie, etc.

"I think it hardly does the Sunberry pie justice to compare it to blueberry pie. They have much in common, but the Sunberry is richer.

"I have never kept account of the yield, nor tried for a large yield. I have a small strip of ground, eight by sixty-five feet, which gave us a pie each day from early August until frost usually about November 1st, and left us a surplus of forty to fifty quarts to can for winter use."

So much for the fruit itself. Then touching on the other aspect of the subject, the writer continues:

"There has been much criticism here, some of it the most senseless stuff I ever heard outside of an asylum, and most of the extreme criticism by those who never grew the plant. One man

an attorney, planted some Sunberries and pulled them up because they looked like nightshade. I completely converted him by sending him a pie."

In conclusion, the writer goes to the heart of the matter when he says: "I think much of this criticism was originally due to some very unfair articles that got copied and were thus spread somewhat generally. As far as I can judge, the original article was written out of pure malice. I can account for it in no other way."

These quotations will perhaps serve sufficiently to suggest the quality of the Sunberry, and to suggest also the animus of the criticism that has been directed against it. It seemed necessary to advert to this aspect of the matter because a fair proportion of the people who have heard of the "Wonderberry" at all have heard only words of condemnation.

Moreover a large proportion of the people who think they have seen or grown this fruit have in reality never seen it.

Whoever supposes that the true "Wonderberry," or Sunberry as I shall always call it, is identical with the ordinary nightshade is laboring under an illusion that might readily be dispelled by inspection of the respective plants themselves.

And whoever doubts that the true Sunberry is an appetizing fruit and a valuable addition to the list of table berries might readily be convinced, had he some neighbor to make the demonstration suggested by our correspondent, through sending him a Sunberry pie.

But let us forget all controversial aspects of the subject and make inquiry as to the origin of the new fruit.

The Nightshade Family

I have elsewhere referred to my interest in the members of the nightshade family, or, as the botanist calls them, the *Solanaceæ.*

The fact that the potato, with which my first experiments in plant development were made, belongs to this family would naturally give me an interest in the tribe. But I was particularly attracted also because of the diversity of characteristics among the almost innumerable and very variable members of the family.

Here, on one hand, are the potato, the tomato, and the egg plant, ranking among our most highly important garden vegetables, and the strawberry-tomato or ground cherry among the minor vegetables that have a good share of popularity; and, on the other hand, closely related species are bearers of the most powerful nar-

cotic poisons, including belladonna and hyoscyamus, drugs that have an accepted place in the pharmacopœia.

Add that the tobacco plant is another member of the family, and it is clear that this is one of the most curiously versatile, and, from a human standpoint, one of the most important of all the plant tribes.

My interest in the family extended beyond the familiar plants just named, and included several species of nightshade that are chiefly known as roadside weeds and bearers of berries some of which are eaten on occasion by country folk, but which in the main have a bad reputation, some of them being accounted highly poisonous.

The name "deadly nightshade," applied to one of the most familiar species, suggests the repute in which these weeds are commonly held.

Yet it is known to the residents of some country districts, particularly in the Mississippi Valley, that the little black berries of the nightshade, if thoroughly ripe, may be made into pies and eaten with at least relative impunity. It is only in lieu of any fruit of more acceptable character that anyone would be likely to make the experiment, however, as the distant relationship of the plant to the deadly nightshade, *Atropa belladonna,* and the henbane, *Hyoscyamus*

niger, from which well-known poisonous drugs are obtained, is at least vaguely recognized, and the plants as very generally held under suspicion.

Nevertheless, the potato, the tomato, the egg plant and numerous other well-known semi-tropical fruits may be cited as affording a convincing demonstration that there is great merit in the family, even though one were to dispute that the tobacco could legitimately be put in evidence in the same connection. And, for me at any rate, there was interest in the knowledge that at least two species of *Solanum* were available for ex perimental purposes that were not under suspicion as to the production of poisonous fruit, however lacking in attractive qualities their products might be.

Progenitors of the Sunberry

One of the solanums in question is a rather large plant known botanically as *Solanum guinense,* which found its original home in Africa, but which has been known for a generation or so in this country, and is sometimes referred to as the "garden huckleberry."

The other is a smaller species, known as *Solanum villosum,* which was indigenous to Europe, but which is said to have been accidentally intro-

duced to California many years ago from seed mixed in the ballast of a ship. This chanced to be thrown out where it had opportunity to establish itself.

The African plant is a strong and heavily fruiting shrub, growing about two feet high on good soil, and spreading to be about three feet in diameter.

It produces large black berries in clusters that stand upright, and that, in the case of some varieties, are nearly as large as cherries. The fruit is not unattractive in appearance and, as already noted, attempts have been made to introduce it as the "garden huckleberry." But such attempts have met with small measure of success for the very excellent reason that the berry is practically inedible.

I have tested it often, and have always found that one berry is more than any person is willing to eat, and I have never known a person who could be induced the second time to attempt to eat this so-called "garden huckleberry," the taste being most villainous.

The plant is indeed somewhat closely related to the black nightshade, *Solanum nigrum,* the American species that is common everywhere, one form of which, known as the stubbleberry, is said to be poisonous, especially if eaten by

children in large quantities when not fully ripe, although fairly palatable when cooked.

The stubbleberry in one or another of its varieties has been used for cooking, in all countries where it grows, when fruit is scarce, chiefly to make pies, as well as for canning. But it is necessary to have the fruit fully ripen; which is often accomplished in cold climates by spreading the berries thinly on shelves and allowing them to mature slowly.

In some regions, as in the Dakotas, the bushes are pulled and hung in the cellar, the fruit being used from time to time as it ripens.

In France the young shoots of this plant are used as a green vegetable, and the plant is even advertised in French catalogues.

The "garden huckleberry," however, differs considerably from the ordinary French stubbleberry, the fruit being much larger in size but far inferior in flavor. It is, however, more nearly free from poisonous qualities, notwithstanding its vile taste.

The differences between the plants themselves are marked, the *Solanum guinense* being, as already noted, a rather heavy shrub, while *Solanum nigrum,* though varying considerably, is usually a slender plant. It may be said, however, that both of these species, like most other

members of the family, show a strong propensity to vary. The black nightshade in particular takes a great variety of forms according to soil and other conditions; each locality having its own variety differing in minor respects from plants of other regions.

I have gone somewhat into detail in this matter, because I wished to establish clearly the standing of the *Solanum guinense* that was used in my hybridizing experiments, and which thus became one of the parents of the Sunberry; and in particular I wished to make clear that this is a species differing considerably from the better known black nightshade, *Solanum nigrum,* with which it has by ignorant or viciously inclined persons been confounded.

The other parent of the Sunberry, already named as *Solanum villosum,* is a plant differing conspicuously from either of those just described. It is low, and tends to a spreading growth a few inches above the ground, never growing upright. The foliage of the plant is pubescent or downy, accounting for its scientific name. In this regard also it is quite different from both *Solanum nigrum* and *Solanum guinense.*

The fruit grows in clusters of five berries that droop characteristically and always remain greenish in color even when ripe, whereas the

fruit of most other Solanums turns black on maturing.

The berries are borne abundantly, and like the tissues of the plant itself they are wholly free from any poisonous qualities. The wholesome nature of the plant is attested by the fact that it is eaten freely by herbivorous animals wherever it grows. Rabbits, cattle, pigs, and poultry eat it with avidity.

Producing the Sunberry

Reference has already been made to the long series of fertilizing experiments through which I endeavored to cross the various Solanums.

I may add that Professor Hansen, of North Dakota, has also been interested in crossing the two fruiting Solanums of which we are speaking, and from which the Sunberry was ultimately produced. But his efforts at hybridizing these species were unsuccessful.

These details are mentioned to emphasize the fact that the production of the Sunberry—although, as will appear in a moment, it came about ultimately as the result of a single successful experiment—was by no means a task to be accomplished offhand by the first person who chose to place pollen of one flower on the pistil

of the other. This was done season after season, seemingly with no effect whatever.

At last, however, in the season of 1905, after I had more than once half decided to relinquish the effort to cross these plants, my perseverance was rewarded.

I had cross-pollenized the great African stubbleberry, *Solanum guinense,* and the little downy nightshade, *Solanum villosum,* as I had done many times before, with no change or added detail of method and for the moment I had no reason to suppose that the efforts had been more successful than before.

But when the seeds were sprouted in the greenhouse, a certain dozen or more plants were discovered that differed from any I had seen before.

These plants were of a new type, and as they developed it became increasingly clear that they represented almost an exact compromise between the two parent species.

There could be no question that they were the hybrids which were so long sought.

But the appearance of these hybrids was such as to corroborate the belief, founded on my long series of unsuccessful hybridizing experiments, that the two Solanums I had finally mated were so widely different in constitution as to stand at

the very limits of affinity within which cross-breeding is possible.

We have discussed a number of instances in which similar crosses have been made between species widely separated. Such, for example, was the cross between the California dewberry and the Siberian raspberry, which produced the Primus berry; also that between the dewberry and the Cuthbert raspberry, which produced the Phenomenal berry; and that between the plum and the apricot, which produced the Plumcot.

In each of these cases, it will be recalled, the hybrid showed intermediate characteristics between its parents, constituting virtually a new species, and proving its individuality by breeding true to type from the seed.

It was rather to be expected, then, that the hybrid *Solanum* would similarly prove its individuality, and the expectation was fully realized.

As the plants came to maturity, one bloomed but failed to produce fruit. The others, however, fruited quite abundantly, some of them profusely.

The fruit was intermediate in size between the fruits of the parent plants. Its quality was entirely different from that of either parent. It had the flavor of the blueberry or huckleberry

of the East, and was especially delicious when cooked.

It differed as widely as possible from the vile-tasting fruit of one parent and from the insipid, tasteless fruit of the other.

It should be explained that there were only about twenty of these hybrid plants in a large colony of seedlings. The remaining members of the company were precisely similar to the mother plant on which they grew—this being the small, downy species, *Solanum villosum*—thus showing that they were not hybrids. It is probable that there was only a single fruit that had been hybridized, although the foreign pollen had been applied to many pistils.

The entire company of new hybrid *Solanums* were probably produced from the seeds of a single berry, the other berries having been quite unaffected by the attempt at cross-pollenizing.

But it sufficed to have produced a score or so of hybrids; I should have been delighted with a single one, after all these years of waiting.

New Species

Naturally two or three individuals were selected from among the twenty hybrids—the ones excelling as to profusion, size, and flavor of berries.

The seeds of these plants were carefully saved, and next season there grew from them a crop of plants precisely like the parents. The progeny of the hybrids followed their parents more closely than the unhybridized offspring of either of the *Solanums* used in the original cross usually do.

As already noted, all species of wild Solanums tend to vary, but the new species reproduced itself *exactly,* except that a very slight difference in the flavor of the berries was barely perceptible.

As two crops of these plants could be raised in a season, they were multiplied rapidly, and there was astonishingly little variation in the size, quality, or growth of the bushes. Without exception the plants resembled the original hybrid, and differed radically from either parent of that hybrid.

It was obvious, therefore, that a new and fixed species of *Solanum* had been evolved through the hybridizing experiment. As the reader already knows, the new plant was christened the Sunberry.

The unwarranted change of the name from Sunberry, the only name I ever authorized or approved for the plant, to "Wonderberry," and the misstatements that have gained currency re-

garding the origin of the plant and the characteristics of its fruit have been sufficiently referred to.

The true qualities of the fruit itself have also been revealed through the quotation from one of the many amateur gardeners who have grown it in successive seasons and found it a valuable addition to the list of garden fruits.

It may be added, however, that the Sunberry makes particular appeal because it ripens late in the season, after most other berries have ceased to bear. It is well to note, also, that the plant shows the hardiness and thrift and vitality usual with hybrids, and will often grow to better advantage on a poor soil and without much cultivation than when especial attention is given it. In most regions, to water it is a mistake, and to fertilize the soil for it an even greater one—making the blossoms drop.

In a word, it is a plant that resents too much petting. It retains something of the character of its wild ancestors.

As to inherent constitution, the Sunberry is a perennial, but it may best be grown annually from seed, quite as its relative the tomato is grown, although that plant also can live from year to year in the proper climate.

As already stated, it grows true from seed year after year, proving thus its specific individuality, and differing not alone from hybrids in general but from the greater number of our cultivated fruits.

The Sunberry has unexpectedly been found adapted to cold northern climates. In the Alberta country, in the latitude of southern Alaska, the Sunberry is highly appreciated, especially as it is about the only berry that can be raised where the thermometer often goes to 40 or even to 60 degrees below zero.

Varying Traits of Hybrids

From the standpoint of the gardener, the Sunberry has importance as a notable addition to the list of small fruits.

From the standpoint of the plant developer it may be said to have perhaps greater importance as illustrating the possibilities of the development of new species by hybridization—species markedly different from, and superior to, those from which they spring.

It is true that other experiments have been detailed that illustrate the production of new forms of plant life through hybridizing already existing ones. A few paragraphs back several of these were named—the Primus berry, the Phe-

LEAF VARIATIONS IN A HYBRID

This very striking picture illustrates the range of variation that may be shown in a crossbred plant. The solid leaf at the left resembles the California dewberry; the leaf at the right shows the characteristics of the Oregon evergreen blackberry—these two being the parental forms. The segregation of ancestral hereditary factors is strikingly shown in these hybrid blackberries.

nomenal berry, and the Plumcot. But in the case of these fruits, it will be recalled, the parent forms were one or both bearers of valuable fruits. The hybrid plants improved upon their parents, but did not show entire departure from the traditions of their ancestral races.

But the Sunberry, as we have seen, sprang from parent forms neither of which produced edible fruit.

This was a union of two racial forms that were separated almost to the point of permanent segregation. The combination of hereditary factors of two distinct species from two hemispheres developed a hybrid that differed very widely from either parent. As it chanced, this hybrid had qualities of fruit that gave it a new appeal and a standing, from the viewpoint of man, quite different from that accorded either of its parents.

The case, then, of the Sunberry emphasizes anew the principle that new *species* may be produced through hybridization, and that, provided the parents are genetically separated just widely enough, their offspring may show such a blending of characters as to constitute a new form, and to be able to transmit these characters to its progeny in such a way as to meet the test by which species are everywhere recognized.

We have seen that there is possibility of hybridization between forms that are a shade more widely separated, in which case the hybrid offspring have the appearance of new species, but lack fertility. Such instances were presented in the hybrid colony of offspring of the dewberry fertilized by pollen from the apple and pear and mountain ash and rose; also by the hybrid between strawberry and raspberry.

These strange hybrids would clearly enough have been entitled to recognition as new species had they been able to reproduce themselves. But their sterility reduced them to the rank of mules—to make comparison with the most familiar instance of an infertile hybrid in the animal world.

From these sterile hybrids the Sunberry differs fundamentally in that it is if anything more prolific than either of its parents.

Meantime the Sunberry differs from the hybrids of another and more familiar type that arise from the union of parents that are so closely related that cross-pollenizing is easily effected between them. Such hybrids, of which we have seen many examples—crosses between the different daisies, between black and white blackberries, thorny and thornless briers, stone-seed and stoneless plums, and sundry others—follow, as we know, a characteristic line of development.

The hybrids of the first generation often resemble one parent more than the other. The hybrids of the second generation show wide variation, some of them reverting to one ancestral strain and some to the other, the characteristics of each being variously segregated and recombined.

Nothing like the direct and complete reproduction of the characteristics of the hybrid in its offspring, as shown by the Sunberry, is manifested in the case of these familiar hybrid forms that spring from the union of closely related species or varieties.

What the Sunberry Teaches

All this should be borne in mind by anyone who is prone to reduce the principles of heredity to formulæ of undue simplicity.

The new formulæ of the Mendelians, for ex ample, which have such admirable application to many cases of the crossing of related forms—where particular unit characters are segregated and recombined—have no application, or to be applied must be greatly distorted from their original implications, in dealing with such a case as that of the Sunberry.

Here there is no clear balancing of dominant and recessive factors, with the overwhelming presentation of the dominant factor in the first

generation and the reappearance of the recessive factor, beautifully segregated, in the second.

Instances of inheritance of that order we have had presented again and again. We shall hear of more of them before we are through.

But, in the meantime, let us not forget the lesson taught by the Sunberry—let us recognize that there are conditions of hybridization under which characters appear to be permanently blended when first brought together; not momentarily linked in an unequal union to be segregated in the next generation, but *fixed* in a *new* and *lasting* combination that strikes a balance between the combinations presented by the parent forms.

It is possible, to be sure, to interpret this aspect of heredity in Mendelian terms. Nor should we deny altogether the validity of such application, for we may well believe that there are gradations all along the line, could we search them out, between the case of the sterile hybrid, born of widely diverged parents, and the case of offspring of members of the same species that differ only as to some varietal character.

The same laws, could we fathom them in their broader aspect, apply to each and every case.

But, on the other hand, it is at least open to question whether it would not be better to re-

serve the application of the Mendelian terms to such types of inheritance as Mendel himself studied, in which there was interplay of dominant and recessive factors, and the varied segregation of the different factors in new combination in the second filial generation.

Thus restricted, the Mendelian formula has individuality and specific meaning.

There is danger that it may lose such individuality and such specific meaning, and with these a large measure of its real value and importance, if the propensity of some present-day enthusiasts to make the words Mendelism and Heredity synonymous is generally followed.

Be all that as it may, at least we hazard nothing in saying that the case of the hybrid Sunberry, sprung at a bound into existence as a full-fledged species, is of compelling interest to the student of heredity, from whatever aspect he may view the subject.

Whatever else may be said of the Sunberry, for or against, the fact remains that it was a successful union of two racial forms that were separated almost to the point of permanent segregation.

A DOZEN OTHER DELIGHTFUL BERRIES

Offering Encouragement to Combine and Construct

IN THE ensuing chapter will be brought together for brief consideration the records of investigations having to do with a varied company of berries, some of them among our most familiar garden fruits, others practically unknown to anyone but the specialist.

It must not be inferred that these berries lack importance because they are grouped here together instead of being given individual chapters. It is only necessary to name the currant, the gooseberry, the huckleberry and blueberry, and the cranberry as members of the list to give assurance that the fruits under consideration have considerable economic importance. But it chances that my work with these fruits, and the others listed with them for present consideration, has been somewhat less extensive than with the small fruits already described.

So much remains to be told concerning the plants with which more notable developments have been achieved, that it seems best to conserve space by treating the fruits that are now under consideration somewhat summarily.

It will appear, however, that the amount of work done in connection with these various fruits is by no means inconsiderable; and that in more than one instance results have been attained that would warrant more extended consideration were it not that they must be viewed in a relative scale.

Let us then somewhat briefly run over the list of a number of interesting fruits that fully justify the title under which they are classified in the present chapter, yet which have associated with them no story quite so spectacular as some others that have been reviewed in recent pages.

We may first recall a few less conspicuous members of the great *Rubus* family—the brambles. The more notable members of this remarkable family have been dealt with at length. But we cannot take leave of so notable a group without at least incidental reference to a few other members of the tribe that have shown interesting possibilities of development.

One of the most interesting among these minor Rubuses is the western raspberry, a wild black

species, known to the botanist as *Rubus leucodermis*. This plant, as its Latin name suggests, has a white stem. As to fruit, it rather closely resembles the eastern black raspberry which is a parent of our cultivated blackcap. It is a strong, vigorous grower, producing stout upright canes and berries that are unusually sweet and of a pleasing flavor.

Several years ago, while in the Eel River region in Humboldt County in California, I discovered many excellent plants of this western blackcap of specially vigorous growth, and producing berries of extra size and quality. A large number of berries were gathered from the most promising plants, and their seeds carefully planted.

After several years of planting and selecting, a promising berry was produced, fully as good, I think, as most eastern blackcaps and much larger than any then known. Unfortunately, the stem and backs of the leaves of the plant are covered with long, sharp prickles, and these are so annoying in cultivating or picking the fruit that it seems not worth while to introduce a plant thus handicapped.

There is opportunity, however, to do away with these prickles through hybridizing and selective breeding along the lines already fully

HAWAIIAN RASPBERRIES

This interesting berry is of fair quality and of the largest size. It does not last long enough for market purposes, but is being used for crossing. The experiments which are still under way give promise of very interesting and perhaps important results.

detailed in the account of the thornless blackberry in an earlier chapter of the present volume. When this has been done, the developed variety of the western blackcap will be worthy of a place in the small-fruit garden side by side with the very best varieties of raspberry under cultivation.

It should be added that this species, like a number of the eastern Rubuses, occasionally produces nearly white berries. These also might be developed into fruits of real merit and doubtless will be when some one finds the time and interest to carry out the experiment of developing them along the now familiar lines outlined herein.

The Cape Raspberry

One of the strangest forms of Rubus with which I have experimented is a species that came to me from New Zealand, but which had its original home in southern Africa.

This form is known as *Rubus capensis,* in recognition, presumably, of its having been found in the Cape region of southern Africa. It is not confined to this region, however, as it is believed to be the same species described by Stanley as growing in various regions in the heart of the Dark Continent.

The fruit borne by the Cape raspberry is of a dark mulberry color. It is of the raspberry type quite unmistabably, but is larger than any other raspberry I have ever seen. The quality of the fruit is fair, and its large size makes it attractive.

The foliage of the plant is peculiar, having a curious resemblance to leaves of the grape. Indeed the resemblance is so striking that people passing it at a little distance have often asked what kind of a grape I had that grew upright like a bush.

The entire plant is highly ornamental, growing about four feet in height and bearing its handsome, large, leathery leaves in profusion. The prickles on the leaves grow so close together and are of such texture that they can scarcely injure the skin in handling them.

The plant is not very hardy, but its other qualities make it a very desirable species for hybridizing experiments. Indeed, I know of no wild species of *Rubus* in the world that gives more promise of being useful. My own experiments with the plant were not carried far enough to produce particularly notable results. But the plant invites attention from anyone who is interested in the further development of our small fruits. Coming from the Southern Hemisphere, it should introduce a tendency to variability in a

conspicuous degree when crossed with some of our northern species.

Among other good qualities of the hybrid progeny, there should be a tendency to prolonged bearing, such as we have seen in the case of the strawberry produced by the crossing of species from the two hemispheres.

The Salmonberry

Another very interesting *Rubus* that shows great possibility of development is the native species familiar along the Pacific Coast from central California to Alaska known as the Salmonberry, *Rubus spectabilis.*

This is a tall, erect bush or small tree with stout, perennial canes. The stalks are usually sparsely clothed with weak, slender prickles, but are sometimes nearly smooth. The flowers are borne singly and in pairs on slender stalks; they are large and showy, being bright red or purple.

In Humboldt and Mendocino Counties, California, I have seen this berry growing in the pastures where it became a genuine tree from twelve to fifteen feet in height, some of the stalks being two or three inches thick. It is reported sometimes to grow six inches in diameter. The cattle in the pastures browse on the plants as high as they can reach, and the berries are gathered

with a stepladder or more commonly from the back of a horse.

The berries themselves are large and soft, almost falling to pieces in the picking. They are unusually juicy, and with almost no acidity.

There are two strongly marked varieties of Salmonberry. One has pale yellow fruit, the other reddish, varying to dark crimson. These two varieties may be seen growing side by side, in some instances without intermingling, each individual bush producing berries of one distinct quality and color.

The Salmonberry requires a damp, cool atmosphere and moist soil. When transplanted into the warm valleys it does not thrive. There chances to be a moist piece of sandy land on my Sebastopol farm, however, where it thrives fairly well. Here we have grown the Salmonberries from Alaska, Washington, Oregon, northern Minnesota, and various parts of northern and central California for more than twenty years.

Among these I have noticed considerable variation in the size and color of both fruit and flowers. My experiments, however, have not been carried out extensively, partly because of the difficulty that attends the growing of the Salmonberry in this locality and partly on account of the lack of firmness and flavor in the fruit. But

I have gone far enough to know that the fruit is worthy of further development, although I shall probably leave the task for some one who is more favorably situated geographically for the cultivation of this particular fruit.

The Japanese Golden Mayberry

We have already learned that the Rubuses are cosmopolites. The facility with which the seeds of the brambleberries of various kinds are distributed by the birds doubtless accounts in part at least for the wide migrations of the tribe, and this in turn accounts for the great range of variation among the different species.

In the course of my experiments with the family, I very naturally looked to Japan to supply material, just as in the case of so many other tribes of plants. The species that I received from there certainly did not appear to be an encouraging plant to work upon. Yet it proved susceptible of development, and well repaid the efforts bestowed upon it.

The plant in question was found growing wild high up on the sides of Mt. Fujiyama in Japan. It is known botanically as *Rubus palmatus*. The collector who secured it for me sent the best specimens of the fruit that he could find, and roots of the plant itself. The plants from these bore

THE BUFFALO BERRY

This plant is indigenous to the Rocky Mountain region and the dry plains of the West. The fruit is edible, and makes a good quality of jelly. Unlike its nearest relative in Japan (the Goumi berry—Elæagnus longpipes) it is not thorny, and in our cultivated varieties every plant bears heavily, while in the wild state the trees are diœcious, only half of them bearing fruit.

large, white blossoms, solitary and drooping on long, slender stems swinging from the leaf axils.

But the berries were a great disappointment, being small and of a dingy, yellowish, unappetizing brown color and their flavor was as unattractive as their appearance.

Knowing the possibilities that lie in the hybridization of oriental species with their American relatives, however, I did not despair of the Mayberry, but hybridized it with the Cuthbert raspberry, a plant that proved a remarkable parent, as will be recalled, in connection with other hybridizing experiments—notably the production of the Phenomenal berry.

The hybridization was effected without difficulty, and the progeny showed a tendency to rapid improvement. After a few generations the berries were greatly enlarged, and took on a bright yellow color instead of the original dingy brown. The improvement in quality was also very appreciable.

But what was perhaps most notable was the extreme earliness with which the hybrid plants fruited. It was, indeed, the early bearing habit of this *Rubus* that stimulated me to make the cross. It proved possible to retain and accentuate this habit while introducing the Cuthbert quality into the berries. The result was a new type of

berry as large as the Cuthbert raspberry, ripening in April, a month before the Hansell, a variety then famed for its early fruiting.

Indeed the hybrid *Rubus* bears fruit at a time when the earliest of the standard raspberries have hardly awakened from their winter rest.

This habit of early bearing, combined with the unusual qualities of the berry itself, seemed to justify its introduction. So it was announced to the public in 1893 as the Golden Mayberry.

The bushes on which the Mayberry grows are distinct from all others of the tribe, attaining a height of six or eight feet and being almost tree-like in form. All along the branches the white, bell-shaped blossoms are pendent, soon succeeded by the large, sweet, golden, semitranslucent berries.

The plants do not at first bear very heavily, but as they advance in age they produce an abundance of fruit.

Unfortunately the hybrid Mayberry is not hardy, and so is not adapted to the climate in many parts of the United States. It has become almost the standard berry in the Philippine Islands, and it is sure to gain popularity in any climate to which it is adapted.

More recently I have given attention to improving the variety, and the developed races bear

luscious fruit fully an inch and a half in diameter. The fruit is rather soft and more suitable for home use than for the market. But it is a productive and delicious berry, well worthy of introduction in all milder climates.

Possibly a series of hybridizing experiments, introducing some northern species of *Rubus,* would result in giving the plant hardiness, in which case it should become popular everywhere. Such a line of experiment is well worth undertaking.

The Cloudberry

In marked contrast to the Mayberry in point of habitat and hardiness is the *Rubus* from the far North that is commonly known as the Cloudberry, or, in some regions, the bake-apple berry, and known to the botanist as the *Rubus chamæmorus,* a name given to it more than a century and a half ago by Linnæus.

The plant inhabits the peat bogs and similar localities far to the north, even within the Arctic Circle. Like many other arctic species of plants it does not confine its habitat to a single continent but is found in northern Europe and Asia as well as in North America. The same thing is true of arctic species of birds and animals; the obvious explanation being that it is easy to wander from one longitude to another in the regions

where all longitudes merge toward a common center.

On this continent the Cloudberry extends southward along the mountain ranges to Maine, on the east coast, and on the west coast to south British Columbia.

The plant bears berries of the characteristic *Rubus* type that are more commonly flattened raspberry shape or nearly globular, of a bright red or yellowish color, and of a pleasing acid flavor. They are highly prized in all northern countries, being among the best fruiting Rubuses of Norway, Sweden, and Alaska and Labrador in America.

It was my good fortune while in Alberta, along the North Fork of the Saskatchewan River, to see this interesting northern species growing wild. The plants with their small, slender, trailing branches and rounded or almost heart-shaped leaves, were very attractive. Some of the seeds were procured for cultivation.

The seeds germinated perfectly and vigorous plants developed. But, although they were placed in as damp and cold a spot as could be found on my grounds, they did not thrive in the warm, dry atmosphere of a sunny California summer. The change from the northern habitat was too great, and, although the plants lived for

a year or two, no important developmental experiments were made with them.

They so obviously found the conditions uncongenial that it was thought best, after a year or two, to discontinue the attempt to reconcile them to the change.

Whoever considers the production of hardy varieties of raspberries, however, should bear the Cloudberry in mind. It offers obvious possibilities as a hybridizing agent to give hardiness of the most "ironclad" kind to a variety that may lack that essential quality.

Possibly the Japanese Mayberry will ultimately be made adaptable to northern climates by such an infusion of new blood.

The Evergreen Blackberry

As further illustrating the wide range of the bramble tribe, we may refer to a species that is indigenous to the South Sea Islands, whence it was introduced into this country and Europe so long ago that there is no clear record of its coming. Indeed, the precise place of its origin is somewhat in doubt.

The species referred to is the Evergreen Blackberry, *Rubus laciniatus*. In our northwestern States, especially in western Oregon, this blackberry is cultivated extensively. It is

popular as a home berry, since it produces fruit from midsummer until late autumn.

As its name implies, this is an evergreen, or nearly evergreen plant. It is a trailing bush with thick perennial canes armed with very stout recurved thorns.

This blackberry was worked upon quite extensively on my place in 1890 and the following years, at the time when my chief experiments in the hybridizing of the Rubuses were at their height. Among the hybrids produced were some very curious forms, the variation in the shape of the leaves being especially remarkable. Some of the leaves resembled those of the grape, others were much dissected, like the leaves of a wild carrot.

The most promising of the hybrids were produced from a cross between the Evergreen and the popular Lawton blackberry. Some selected seedlings from this cross, in the second generation, were rampant growers, thorny, with curious, handsome, palmate leaves, and delicate pink blossoms. The berries ripened late in the fall. Some were rather large and possessed a superior aromatic sweet quality not found in the common summer varieties.

One of these promising hybrids was mentioned in my "New Creations" in 1893. It was

never introduced into cultivation, however, as its merits were not quite equal to those of some other varieties of different parentage. But there is no doubt that if the experiments with the Evergreen blackberry, of this or some other hybrid combination, were carried to a more advanced stage, really useful varieties would be obtained.

The Common Currant

Notwithstanding the importance of the Rubus family, its members have by no means a monopoly among the popular small fruits of the garden.

There is at least one other bush that may claim to compete with the brambles in wide range of habitat and in general popularity among gardeners. This, of course, is the familiar currant.

The forbears of the currant grow wild, represented by various species in both Europe and America. The wild red species, *Ribes rubrum,* from which all our common cultivated red, white, and pink currants, large and small, sweet and sour, are descended, is indigenous to both continents. It has maintained its specific identity remarkably through long generations, as the close similarity of the specimens found wild in Europe and America testifies. The more com-

INTERESTING HYBRID BERRIES

Some of my most recent and interesting experiments have been with new types of berries. The boxes here shown contain some second-generation seedlings of berry crosses. There are also a number of straight seedlings, of both parents, in some slight way indicating the range of a season's work along a single line.

mon American wild species, however, in most regions is the black currant, which also has a European congener.

The American black currant is a hardy plant, growing far north in Canada. It varies greatly in different regions, both in appearance and in the quality of the fruit it bears.

There are other wild species and varieties without number, so that there is abundant material supplied the plant developer for work with this valuable fruit.

I have experimented with a large number of varieties from different regions, and have produced some interesting anomalies. One of these was the result of crossing the varieties of a native red-flowering species known as *Ribes sanguineum*. By selection and cultivation, varieties of this plant have been produced on my grounds that bore flowers of brilliant colors and the largest fruit, perhaps, ever seen on a currant bush.

Most of the crosses of this species were made between a form collected on Vancouver Island, British Columbia, and the forms native to the regions about San Francisco. The Vancouver forms had long racemes of light crimson flowers and small bluish fruits. The coast form has larger fruits with a more resinous odor, the ber-

ries varying in color from bluish to black. My efforts with these species were mostly directed toward increasing the size of the fruit. As just stated, the results are quite noteworthy.

But the experiments are still under way and the ultimate possibilities of development are yet to be revealed.

These experiments in hybridizing the currant have extended to all the species and varieties that could be obtained. At times I have had five thousand crossbred currant seedlings under observation.

In addition to the European and American crossbred species, I have worked extensively on varieties imported from Japan and China, and from northern Asia and Russia.

I have also crossed the currant with the gooseberry, but the hybrids in this case produced no fruit. Notwithstanding the large number of experiments and their interesting results, I have not produced any new currant that was thought worthy of introduction. There is now under observation, however, a hybrid seedling from the Californian species already referred to—*Ribes sanguineum,* which is several generations removed from the original, and which bears long clusters of extremely large blue berries with few seeds.

This is the best of the thousands of hybrids grown, though I have produced a few really good currants of unique form and flavor, as well as some flowering currants of unusual size and beauty.

All in all, my work with the currants, while substantiating and emphasizing the principles of plant development that work with other plants had made familiar, and while showing many features of interest, has not resulted in any very striking developments; largely, perhaps, because attention was diverted from this line of work to other experiments of greater immediate promise; and because the experiments were too radical, taking in so many species that so many unique characters appeared that I had not time to segregate them. If I had worked with a single species, more immediate commercial results would have been attained. Much of the work with currants was done for its æsthetic and scientific interest rather than for immediate commercial prospects.

The Gooseberry

The currant has a very close relative which vies with it in popularity, particularly in England—the familiar gooseberry. This plant, indeed, is in reality a currant that has developed

or retained the habit of bearing prickles both on the stem and often on the fruit itself.

This is the practical distinction between the gooseberry and other varieties of currants. All the plants of this tribe belong to the same genus. There are several species in California that puzzle a botanist as to whether they should be classified as currants or gooseberries.

In Europe, and particularly in England, the gooseberry has been cultivated with the greatest possible care and through selection the fruit has been brought to a very large size, superior quality, and unusual productiveness.

But unfortunately the thorns have never been eliminated, except in the case of one or two inferior varieties. These were offered several years ago by an English firm, but their quality of fruit was so inferior that they have not become popular.

It has already been mentioned that I was able to hybridize the gooseberry and the currant. The cross is very difficult to make, however, and in my experience the hybrids were sterile. This suggested that the two plants, notwithstanding their affinities as judged from the standpoint of the botanist, have really diverged rather widely.

But there are many species of gooseberry as well as of currant, and it would doubtless

be quite possible to find varieties of the two plants that have closer affinity. The hybridizing of these would offer interesting possibilities.

Experiments with the gooseberry as with the currant have been extensive and have produced a great number of gooseberries of superior quality; none, however, until very lately have been really notable.

Some of the most interesting experiments had to do with the native species known as the Coast gooseberry, *Ribes divaricatum,* which grows around Tomales Bay, but have also worked with the Canyon gooseberry, *Ribes Menzieszi,* a tall, rapid-growing shrub with rather small leaves and very prickly stems.

The berries of this variety resemble a chestnut bur rather than a gooseberry, the spines occupying the whole surface of the fruit. The fruit itself is excellent in flavor and is prepared for eating by being placed in hot water so as to soften the prickles, after which the pulp is easily crushed out.

I have developed several partially thornless varieties of this gooseberry, and have also had partially thornless ones sent me, showing that the species tends to vary in this direction. But the seedlings from these partially thornless

plants always produced thorny varieties. It is probable, however, that further experiments might reveal specimens that would drop the thorns altogether and would breed true to thornless as the thornless blackberries do.

This, indeed, should be the aim of the plant developer in connection with all varieties of gooseberries. The plant offers a splendid opportunity for hybridizing and careful selection.

If it could be induced to shed its thorns and still bear large fine fruit, the gooseberry would gain enormously in popularity. At present there is a not unnatural prejudice against this fruit because the thorns constitute an almost intolerable nuisance, their sting being peculiarly irritating.

My own experiments were carried far enough to suggest the probability of the production of good thornless varieties. As to fruit, several varieties were produced that were thought superior to any previously seen. But I was not able to introduce them properly, and after keeping them several years the bushes were destroyed to make room for other plants of greater promise. Subsequently, however, I regretted this and now feel that these plants might have rewarded further experimental efforts had I been able then to find time for them.

Certainly the gooseberry is well worthy of greater attention, from some plant developer who works along modern lines, than it has hitherto received.

The Blueberry and Cranberry

Another interesting tribe of plants supplies us with the familiar market fruits known as bilberries, blueberries, and cranberries.

These berries are little grown in the garden, but remain even to this day products of the wild, although the bushes on which they grow may be taken under man's protection and given a certain encouragement in woodland or swamp.

The botanist classifies the various blueberries and cranberries in the genus *Vaccinium*. There are widely scattered representatives of the tribe in both hemispheres. Most of them are branching shrubs or creeping vines. A large proportion of them are vigorous shrubs like the various blueberries; whereas on the other hand the cranberry is a trailing evergreen. The varieties in the different species are so numerous as to tax the skill and patience of the botanist.

The berries are produced in enormous quantities. A mass of blueberries in fruiting time may seem to spread a blue carpet throughout acres of cleared woodlands and pastures. And

as to the cranberry, on my father's meadow lands where these plants grew, we used to rake the berries off the vines instead of picking them by hand, so profusely were they clustered.

A very interesting feature of the blueberry and cranberry pastures, observed even as a boy, was the great variation, sometimes within the same square rod of ground, not only in the size of the berries, but in their shape and quality.

From the same patch, some blueberries would be sweet and very highly flavored, others insipid and more or less flavorless. But individual patches of the low blueberry *V. pennsylvanicum* as a rule appeared to be developed from one original seedling which had suckered out in various directions just at the surface of the ground, the trailing branches rooting under the fallen leaves wherever they touched the earth.

Individual groups of plants, sprung thus from one seedling, would of course show the same qualities of fruit.

On one of my last visits to New England I selected from the old blueberry grounds some of the best plants, and transplanted them to the experiment farms at Sebastopol.

It has often been stated that the blueberry cannot be cultivated to advantage, because it ceases to produce much fruit when removed from

the wild state. My experiments did not justify this belief, as the bushes brought from the East were if anything overproductive. I have never seen plants of any kind produce a greater quantity of fruit in proportion to the weight of the plant.

During the ripening season the bushes seemed to be a solid mass of berries. This overproduction of fruit greatly restricted the growth of the plants themselves.

One season, by way of comparison, all the fruit was removed from a certain number of bushes. Relieved of the burden of fruit production, these plants made a large growth, quite outstripping the others; and the second year they produced an unusual crop. Under proper conditions, the blueberry may become profitable under cultivation in California and no doubt will, sooner or later, be largely grown.

The same may be said about a collection of huckleberries, bilberries, and other blueberries of various kinds that I had gathered from British America, Oregon, Washington, and even Norway, and of an allied plant said to be of unusual value, that I received more recently from the mountains of central Japan. No important results from the development of this plant have as yet materialized, however.

The blueberry and huckleberry are generally thought to be extremely difficult to raise from seed. But if kept sufficiently moist in a peaty soil this may be readily accomplished.

Cranberry seedlings can be grown by washing out the seeds and sowing in a protected place or in damp sphagnum moss.

The young seedlings can be transplanted like other fruiting plants, but the operation is rather delicate as with all other Vacciniums. The soil must always be virgin soil, and with hardly a trace of lime, as all Vacciniums prefer what is commonly called an acid soil.

The cranberry, like most other members of the tribe, spreads by sending out runners. It can be propagated by cutting the vines into small pieces. The plant does not thrive in California except in some bogs of the northwestern part of the State. In regions to which it is adapted, however, the cranberry is a crop of considerable importance, and there appears to be an unusually good opportunity for some one to conduct experiments for the development of better varieties.

Mere selection from the existing varieties would probably accomplish much. And of course still further progress could be expected if the different varieties were hybridized. By such

work the crop could without doubt sooner or later be more than doubled in quantity, the size of the berries greatly increased, and their quality improved.

The most desirable characters for the plant developer to have in mind would be, first, quality of the fruit; next, size and color. The vines themselves could be readily improved, both as to manner of growth and abundant production.

Here as with other berries it would perhaps be possible to eliminate the seed, and this would obviously be of some advantage.

The cranberries differ less than plants that have been more under cultivation, but they nevertheless show enough of variation to give full opportunity for selective breeding; and of course the variation could be increased by crossing as with other species. The common swamp blueberry *V. corymbosum* is one probably promising the most in the way of improvement for general cultivation.

Two Interesting Tree Fruits

To conclude this survey of common fruits that beckon the plant developer, yet which have been largely neglected, brief reference must be made to the berries of two plants that differ radically from those we have had under consideration,

A NEAR VIEW OF TWO BOXES OF BERRY SEEDLINGS

These are second-generation hybrids. They were raised in the season of 1914, *and had not then come to bearing. Interesting results have been obtained from these plants.*

inasmuch as they are trees or large shrubs rather than bushes.

The plants referred to are the Mulberry and the Elderberry.

The mulberry is a relative of the fig, and it bears abundantly a fruit that is distinctly suggestive of the blackberry in general appearance, but which has a characteristic flavor of its own.

Although the fruit of the mulberry is not altogether neglected, yet in general the tree is raised to furnish food for the silkworm or for ornament rather than for its fruit. It is obviously difficult to gather a crop of berries distributed among the branches of a tree, and this fact no doubt accounts in part at least for the failure of the mulberry to gain general popularity as a fruit producer.

It would be possible, however, to train the mulberry tree to a lower and more spreading growth, as it is generally propagated by grafting after the manner of orchard fruits. Indeed, that is the best way to propagate the fruiting varieties of mulberry, as they cannot be depended on to breed true from the seed. In fact, the fruit of several of the best cultivated varieties is altogether seedless.

Reference has been made in another connection to my experiments in hybridizing the mul-

berry with its relative the fig. Notwithstanding the lack of success of these experiments, mostly no doubt from lack of time, it seems possible that further experiments along the same line might lead to interesting, and perhaps to very valuable, results.

As to the other berry-producing tree just mentioned, the elder, the possibilities of fruit development are even more inviting.

The common European elder, *Sambucus nigra,* has developed into a number of handsome ornamental varieties, most of which are offered by the American nurserymen. Our native eastern species, the *Sambucus canadensis,* the common elder of the eastern United States, has also developed several forms; and there is a California species, *S. glauca,* that shows a like tendency to variation, both as to size of tree and size and quality of fruit.

The berries of the elder are borne in large clusters, sometimes in enormous profusion, so that the bushes fairly break under their weight. The fruit is generally bluish black, with a very thick white bloom.

A curious anomaly is sometimes shown by another European or Asiatic species, *S. racemosa,* a variety of which grows in various parts of northern California and northward along the

Pacific coast. This sometimes makes a large, rambling, treelike bush, and the singularity in question consists in the fact that some of the bushes bear berries of a brilliant yellow color and others reddish purple or almost black berries.

The bushes intermingle almost indiscriminately, yet there is no intermingling of the different berries on the same bush. Each plant bears exclusively berries of one color or the other.

I have experimented extensively in the improvement of the berries of the different elders and these experiments are still under way.

These experiments began with the planting of seeds of the Mexican elder, which bore berries of medium or small size and of black color. Some of the plants that grew from these seeds produced, much to my surprise, berries yellowish white in color.

Observing this tendency to variation, it at once occurred that improvements might be made in almost any direction with a plant that showed this tendency. More seedlings were raised, and selection was made according to my usual method.

From the best of these seedlings many plants were produced that bore berries of a yellowish white or sometimes grayish color. While the

berries were bitter, like elderberries in general, I noted that some were less bitter than others. Moreover, there was a diversity in size, and a great variation as to productivity. A few of the trees bore a constant crop all summer, blooming and bearing fruit throughout the season and well into winter.

This was another unusual break in the traditions of the family and one that seemed to offer pleasing possibilities.

The experiment has continued along the lines of further crossing and selection. A few seasons ago I had from twenty-five to thirty thousand elder plants in bearing. From these the best, to the number of about seventy-five, were selected. And the trees of the generation now under observation bear really delicious berries, without a trace of bitterness. Some are quite sweet, others acid.

The best of them are an astonishing improvement over any elderberries I had ever seen before.

The berries are grown in abundant clusters and they are individually of the size of small currants. When dried they turn a light golden color, like the whitest of the white raisins. In flavor they can hardly be distinguished from the best raisins, though so notably different in size.

The progress already attained makes it certain that we shall soon be able to educate these elders to a condition that will make it highly acceptable as a productive fruit, especially for arid regions. The elder grows from cuttings and will thrive in moist or dry climates.

I have under way also a series of hybridizing experiments in which the different elders, notably the progeny of the Mexican elder, and the California species already referred to, *Sambucus glauca,* and the hardy Dakota elders are combined. To produce still further variations and facilitate progress, I have also crossed the new elder with species from Arizona, one of which is a very large tree for an elder.

From a second generation cross I got probably one individual in forty that bore black berries, but from the third generation not a single one out of several thousands was black. One was secured, however, that bore berries of a gray or mulberry color and two or three having a tendency to a mixed color. All the rest were white or amber.

It will appear, then, that a race of elders has thus been produced that bears fruit of an attractive white or amber color and of such quality as to commend it highly, as a fine substitute for other berries, in regions where the garden fruits

in general do not thrive or perhaps even where they do. Moreover, there is every probability that the experiments now under way will result ultimately in the development of varieties of elder of such improved quality as to make a valuable addition to the orchard even in competition with the most popular fruits.

The elderberry has qualities of its own that will commend it strongly. If for no other reason, the fact of its development on a tree or large shrub gives it peculiar attractiveness. The vine-like growth of many bearers of small fruit, notably the raspberries and blackberries, necessitates methods of cultivating, with perpetual pruning that many horticulturists find irksome. The elder shrub can take its place in the fruit orchard along with the trees that bear apples, or plums, or peaches, requiring no special treatment or attention, and constituting a permanent acquisition for the fruit grower.

There are opportunities in the bypaths of plant improvement, opportunities untold, which call out for patient specialized effort, and which will well repay the investment of that effort.

GREAT OPPORTUNITIES IN THE GRAPE

Generations of Grape Experiments Help Us

THE grape is the patrician among climbing plants as the strawberry is among trailers. The family to which it belongs is one of the smallest, as regards number of species, among plant tribes. But it is an oligarchy having very great distinction. What the membership lacks in numbers it makes up in quality. The grape is known everywhere and has been cultivated by man from the earliest times. Doubtless as much attention has been given to it as to any other tribe of plants. Indeed there may be no other that can compete with it in this regard.

Of course the main reason for the extreme favor shown the grape by man has been all along the capacity of the plant to produce a fruit having a juice of unique quality.

It is as a producer of wine rather than as a producer of fruit for the table that the vine has

in the past everywhere gained greatest popularity.

Nevertheless, the quality of its fruit is altogether noteworthy, and such as to give the plant distinction in the eyes of the horticulturist, even were it considered solely as a producer of table fruit. Moreover, there are certain kinds of grape that contain so high a sugar content that they dry without fermenting, constituting a third important commercial product—the raisin.

All in all, then, it is easy to understand why the grape must be considered as a fruit standing in a class by itself, and having importance second to none.

The manner of growth of the grape and the character of the clusters in which its fruit is borne are no less distinctive. No other fruit under cultivation in the least resembles the grape in either regard. And as to shape and appearance of the individual berries no less than in the matter of fragrance and flavor the grape manifests the same individuality. Different varieties show diversity of form and color and flavor, to be sure, but no grape of any variety is likely to be mistaken for a fruit of any other kind whatsoever.

It is clear that we cannot attempt in the space at command to present anything like a compre-

hensive story of the growth and development and world conquest of this extraordinary fruit. Nor would it comport with the present purpose to do so. The main facts as to grape culture are matter of common knowledge. Our concern must be with such features of habit, and constitution, and adaptability of the grape as particularly concern the plant developer, and have to do with the possibilities of improvement.

In particular, of course, here as elsewhere, we shall be concerned with a presentation of the work done at Santa Rosa and Sebastopol in connection with the development of this plant.

This, as will appear presently, has looked chiefly to the improvement of the grape as a table fruit. I have not been concerned with varieties of the grape that are utilized by the maker of wine. These have been specialized to the point of approximate perfection in the wine-growing districts, and it would be useless to experiment with them in any region except the one in which they are to be cultivated, because it is well known that the grape takes directly from the particular soil in which it grows something of the unique qualities of flavor that determine the rank of any grape in the estimate of the connoisseur.

But the case of the grape considered as a table fruit is obviously different. Even though this

GRAPES OF THE CONCORD TYPE

The familiar and always popular Concord grape has naturally been given attention. It has produced improved varieties by direct selection, without crossing, although it has also been used in hybridizing experiments.

also is doubtless influenced by the soil, the tests applied to it are not of quite so refined a character, and the grape developed in one region may be expected to retain at least approximately its unique flavor when grown in another climate.

So I have striven to develop varieties that would have commendable qualities of fruit and such qualities of hardiness of vine and prolific bearing as would make them suited to cultivation throughout wide territories.

Here as elsewhere it was had in mind the needs of horticulturists not in one region merely, but in many regions, and I have endeavored to produce plants having the widest possible adaptability to varying soils and climates.

The measure of success that has attended this effort in the case of the grape will be partially revealed in the ensuing pages.

During a period covering forty years I have probably raised no less than 75,000 to 100,000 seedling grapes from the best table varieties. I have hybridized many varieties, both European, American, cultivated and wild; also other wild species from Mexico, Australia, China, and Japan, and have likewise attained interesting results by working with bud sports, and with the tuberous grape of Mexico.

Materials and Method

To raise grape seedlings, it is only necessary to gather the seed from the variety desired, and keep them barely moist until planting time. Plant as soon as the frost is out of the ground in well-drained land, in rows about three or four feet apart. Scatter the seed thinly in narrow drills. Cover with sandy or leaf-mold soil, about one inch deep in a humid climate, a little deeper in dry soil like that of California.

In the latter case it is well to have the upper half of the covering of sawdust, so that the seedlings do not have too great a weight to lift in pushing through the soil.

During the summer the very poor seedlings, those which are attacked by mildew or which have made weak, uncertain growth, may be uprooted at once, giving the others a better chance. Later, while the plants are dormant, transplant the most promising of these to rows about twelve feet apart, the individual plants being from one to two feet apart in the rows, according to the variety.

Like most other cultivated fruits, grapes do not come true from the seed. Among American grapes, if seeds from a vine bearing black fruit are planted, about ninety-nine out of one

hundred black-fruited seedlings may be expected. With red grapes about the same proportion will follow the parent color. But from a white grape probably less than one-fourth will come white.

With the European grape, *Vitis vinifera,* the most variable and commercially the most important species in the world, the proportion would be wholly different in most cases. Planting a red grape one may expect half red or half black, the tendency being slightly more toward red or black grapes than white, but the proportions varying indefinitely.

Certain qualities of the inherent constitution of the plant are markedly heritable.

Thus the seeds from a strong-growing variety are likely to produce strong-growing seedlings. Productive grapes will usually produce a high proportion of productive seedlings. A grape subject to mildew is almost certain to produce a large proportion of seedlings subject to mildew.

A variety having abnormally large leaves will not often reproduce that tendency in its seedlings, for an abnormality is more apt not to reproduce itself, there being a tendency to return to the normal condition, which has existed for perhaps a thousand years.

SEEDLING SYRIANS

Several years ago we secured cuttings of the best Syrian grapes brought from Palestine and vicinity. The Syrian grapes are characterized by a rather slender, but strong and wiry stem, and by bunches of pleasing form, all of about one size, and not so crowded on the branch as many varieties of common grapes. The seedlings vary greatly.

By planting seeds of an early grape, a great proportion of early grapes would be expected, and vice versa, but in almost every case both early and late, large and small, black and white, sweet and sour, strong-growing and weak-growing grapes will be produced among a lot of grape seedlings from any variety which has been long cultivated and is the result of hybridization.

In a wild species, the variation would be mostly in the size of the plants and very little in any other respect.

The first crop of fruit on the young vine is not a very accurate test of its future fruiting capacity. Almost without exception the fruit improves each season for several years both in the size of the bunches and in quality of the fruit.

Grapes from Many Lands

With the grape as with other plants I have sought material for development in far places; but have also utilized the native species. A brief notice of the different species that have contributed to the experiments will suggest the scope of the work.

An interesting local species is *Vitis californica.* This is an extremely strong vine, climbing a tree to a height of seventy-five or one hundred feet. It is often found along the banks of creeks and

rivers where it may attach itself to a young alder. As alder and grape grow, the tree supports the vine until it reaches a height of sometimes one hundred feet and has a trunk twelve to eighteen inches in diameter—which may seem almost incredible to Eastern people unfamiliar with our flora.

The fruit of the California grape is produced in small quantity and is quite variable in this locality. It ripens late, is sour, without flavor, and is generally insignificant in all respects. It is sometimes used for jellies.

Of the world-wide and supremely important commercial species commonly called the European grape (*Vitis vinifera*) I have worked largely with the Tokay variety with the idea of inducing this vigorous vine, which bears such an abundance of large, handsome fruit, to combine hardy qualities and freedom from mildew with its characteristic excellence of fruit.

The fruit of many of the seedlings is quite acid, but some are far sweeter than the Flame Tokay, and much earlier, which is most important as the Flame Tokay ripens too late for our coast climates.

These seedlings have of course been rigidly selected to avoid mildew, susceptibility to which is one of the faults of the Tokay, especially in

the coast region. Some of the seedlings of the Flame Tokay are white, some black, some reddish, some of a blue-gray color. Very few of them resemble the Flame Tokay in form, color or quality of fruit, most of them incline to the round form of the ordinary *V. vinifera.*

It is not uncommon to find natural hybrids of the California grape and the European grape growing wild alongside the vineyards. The strains of the California species are in some of the strongest-growing forms of cultivated grapes that are recommended as stocks for the varieties of European grape that are subject to injury from phylloxera.

Work with Strange Species

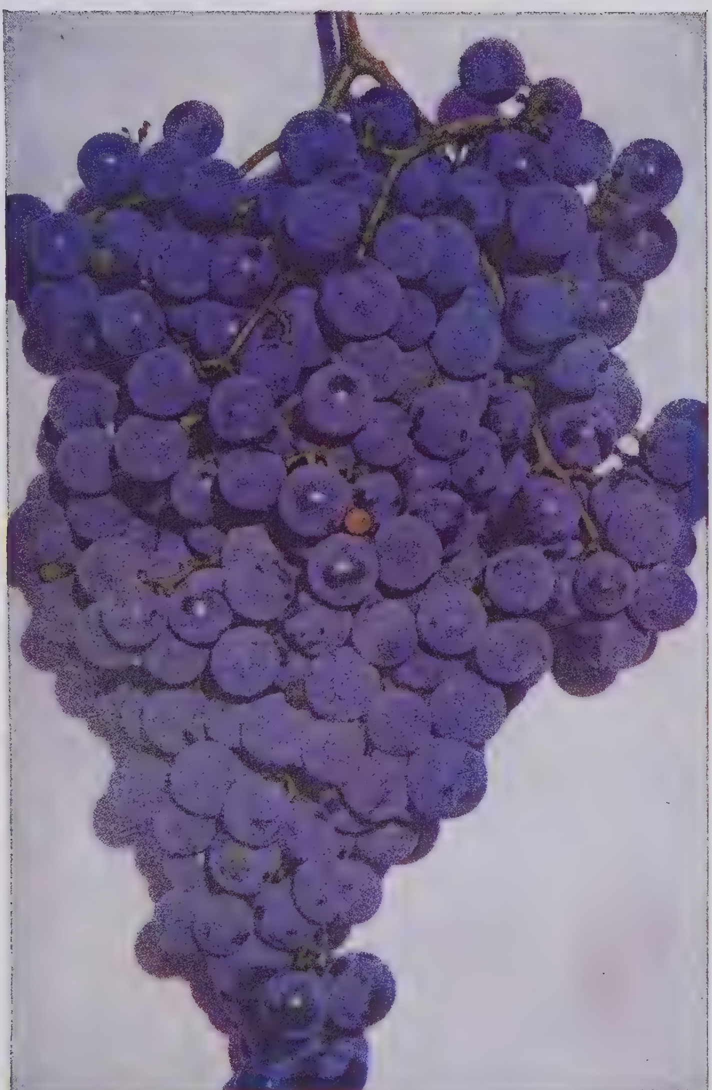
Mr. M. K. Seralian, who removed from Palestine to America some years ago, secured cuttings of the best Syrian grapes. The vines from these cuttings have habits of growth not unlike those of the Flame Tokay seedlings planted at the same time, and are now about the same size.

Among them is one identical with our so-called Sweetwater grape.

Another was certainly Thompson's Seedless —a stray variety renamed since it was imported to California about 1880, and recently identified as *Sultanina.* It is an extremely productive,

A MAMMOTH CLUSTER

One of the Syrian seedling grapes, and still unnamed. The individual fruits are large, but notable for the extraordinary number in a bunch, as the picture will show. They are of most excellent flavor. This cluster was about fourteen inches in length by eight inches across.



light-colored, strong-growing, yellowish-white grape which has to be pruned longer than most others of the *vinifera* class in order to get big crops which it produces under ordinary vineyard cultivation in California.

Sultanina and another called Sultana are grapes of medium size but absolutely seedless. They are put up in great quantities in California as seedless raisins, and are displacing the dried grapes of Corinth or so-called Zante currants so extensively imported from Greece and Turkey —to which they are greatly superior.

Among these seedlings of Syrian grapes there is one early and productive class, absolutely new to California growers. Most of the Syrian grapes are noticeably different in several particulars from the other grapes of Europe and northern Africa.

The stems are more slender, the peduncles quite small, yet strong and wiry, the clusters are very pleasing in form, the grapes usually being set full and all of one size, and the clusters are not usually so crowded as those of many varieties of the common grape. The seeds also are very small—almost absent. Yet all of the varieties among this lot of twelve or more produce some seeds, with the exception of the Thompson's Seedless. The seeds, however, are quite

tender, being hardly noticeable. The skins of most of them are thin and transparent.

Having raised a great number of seedlings from these Syrian grapes, I find them to be remarkably precocious, coming into fruitage early, remarkably heavy croppers, and while more uniform in character than most of the *vinifera* seedlings, yet they nearly all contain an astringent principle which is seldom found in the ordinary grapes. With this exception, they are the most promising lot of seedlings which I have hitherto raised.

About 1890 the United States Government imported a lot of grapes from the Mediterranean region, but none of them compared with these Syrian grapes, which seem to be distinct, and some of which will probably prove of great value to California.

Most of these grapes are oval in form, not round as is usual with other grapes.

The *Vitis antarctica,* which has several other botanical names, is a curious climber from Australia which I have grown many times from imported seed. It is a little tender and especially sensitive to wet weather, and though it is interesting I have not experimented much with it.

The *Vitis Coignetiæ* from China is an exceedingly strong-growing vine with immense leaves.

The foliage is beautifully colored in the fall—scarlet, crimson, yellow, or brown. But there is a great diversity in the seedling vines in the color of the foliage. Those with brilliant scarlet autumn colors are generally considered the best. There are also crimson ones. There was a vine growing on my Sebastopol bungalow for years which bore small clusters of insignificant fruit, but handsome foliage.

The *Vitis hypoglossa* is another uncommon grape which I have grown for my own amusement and interest.

The *Vitis rotundifolia,* which has also half a dozen more botanical names, is a tremendous grower. It must be thinned out quite extensively in order to get any fruit; the seedlings of these make a mass of foliage and small branches, so there is no opportunity for the vines to produce much fruit.

The various Scuppernongs are derived from this Southern species. I have grown them from seed on numerous occasions. In a few cases these have produced scanty fruits, but they were finally destroyed as they make too much growth and too little fruit.

I have also grown the mustang or everbearing grape, *V. candicans;* the sugar grape, *V. rupestris;* the *V. monticola, Texana* or *Fœxeana,* the

UNPRODUCTIVE BUT MERITORIOUS

Like all of the seedlings here shown, these two are of mixed ancestry. Both have qualities of size and superior flavor, but the bunches are too small for a market grape.

V. vulpina or *cordifolia*—in fact, I have worked more or less with nearly or quite all the North American species and many of the hybrids produced by Mr. Munson and others.

Seeds of the tuberous grape of Mexico have been sent me several times. It seems to require a thoroughly well-drained soil and a very warm climate.

The first two lots of seeds received were failures on account of being placed in irrigated soil which was not suitable to them.

Some of the third lot of seeds were placed in sandy, well-drained soil, and made large vigorous vines the first season. They somewhat resemble the Muscat of Alexandria in foliage and growth and have rather large, sweet potatolike roots. However, our winter climate did not suit them and these also died, so I have made no further attempt at raising them.

These Mexican tuberous grapes are said to produce a fine fruit in large clusters, much resembling the Muscat of Alexandria.

Variations in Seedlings of a Bud Sport

My constant effort to take advantage of any disturbance in the heredity of a species or variety is justified strikingly in working with the grape.

The best seedlings which I have ever produced were from the grape called Pierce or Isabella Regia, a variety which originated as a sporting branch from the common Isabella on Mr. J. P. Pierce's place near San Jose, California.

This Pierce grape is the same color as its parent, the Isabella, but the berries are more than twice as large though not increased in number on the cluster. The vine is very much stronger and the foliage much larger, so much so that the difference is noticeable at a considerable distance.

Large quantities of seedlings from the Isabella Regia were raised, partly for the purpose of noticing whether bud sports would reproduce themselves from seed and partly because it promised to be a fine variety to work upon for improvement.

Among the numerous seedlings which were fruited the variations were most astonishing, much more so than with most grapes.

Whether this is on account of the Isabella having been moved to a new climate, thus changing its hereditary tendencies, or whether bud sports in general are apt to produce more variable seedlings, I am not yet able fully to demonstrate. Some of these selected vines which were fruited are unusually strong growers, some were as weak

in growth as the ordinary cultivated varieties of grapes; some bore enormous bunches of grapes, some had only a few small clusters.

One of these Isabella Regia seedlings is the earliest grape ever recorded, ripening nearly a month before the Early Amber, Sweetwater, and other American and European grapes. It is, however, small in size and not productive.

The Earliest and Latest Grapes on Record

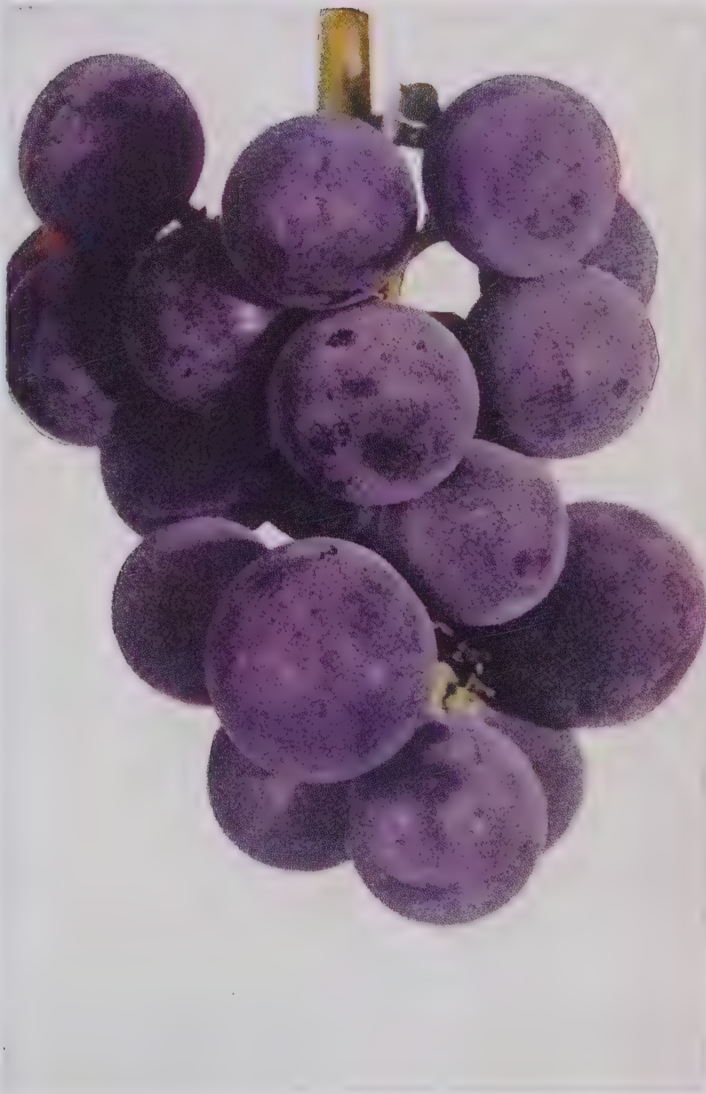
Another very large black grape, produced on a large, vigorous vine, ripens nearly five weeks before its parent. This is the earliest large grape known. It has very delicious flavor and quality. It was temporarily called the "Early Black," but was subsequently rechristened the Montecito by Mr. John M. Rutland, who purchased it for introduction in Australia.

In contrast with these early-ripening seedlings are others that do not fully ripen their fruit until December and January. These are valuable in California if protected from the rains, as they extend the season almost indefinitely.

Though the parent plant bore black grapes, some of the seedlings bore white, yellow, red, or purplish-black fruit. Some varieties were enormous producers.

SMALL CLUSTER OF A FINE SEEDLING

An unusually large seedling grape with a fine flavor. It would almost seem as if in this seedling the weight of grapes which would ordinarily be found on a large bunch had been combined into a few fruits individually of exceptional size. The clusters of this variety are about twice the size of the one illustrated.



Owing to pressure of other matters, I have made no attempt to introduce any of these grapes, but am satisfied that none can compete with some of them for table use.

Among the seedlings of the second generation raised from my own vines were three anomalous vines of great interest. One of these was the exact counterpart of the California wild grape.

The second was closely similar though not quite identical; and the third might be called a hybrid in general appearance.

As there were no wild California vines growing within fourteen miles of the place where these grapes were growing, I can only account for the appearance of these degenerates, as they might be called, on the theory that our wild California grape and the Eastern wild grape from which the Isabella originated were descended from a common stock, and these three plants were reversions.

Two of these vines grew the first season to the height of nearly eight feet when the other seedlings had grown to only one or two feet in height. The third one grew twelve feet or more, while most of the others had grown only about as many inches. The foliage was exactly like the California wild grape, as was the wood, fruit, and general appearance throughout.

These seedlings have created much speculation as to their heredity among experts who have seen them. They are best explained, I think, on the theory proposed above.

Nearly three-fourths of the Isabella Regia seedlings bore partially seedless fruit. About half the grapes on each bunch usually were altogether seedless. Some entire clusters were seedless. Yet other vines of the same fraternity bore fruit in which the seeds were unusually large.

By selection among these vines I have developed several races of nearly seedless grapes that are of exceptional quality. The best of these will be introduced, and they will also be of value in hybridizing experiments for the production of seedless grapes of other varieties.

Once produced, such varieties must obviously be propagated by cuttings, but this of course presents no difficulties.

The matter of hybridization, crossing, and selection of fruit having been gone into quite extensively in early chapters, only a glimpse of the special features of the work with the grape has been here recorded. The methods of crossing and selection having been discussed in previous chapters, it would be mere repetition to give them here; and for this reason the details have not

been elaborated as fully as in some chapters on other fruits.

A great number of experiments with the grape are now being carried on that are approaching completion, and I have a large number of unique and valuable grape varieties which are awaiting introduction.

INEDIBLE FRUITS WHICH MAY BE TRANSFORMED

Even the Acrid Barberry Is Changing

We have had occasion more than once to call attention to the extraordinary importance of the Rose family in its relations with man, and in particular to the wonderful value of the great genus *Rubus*.

The family gives us an astonishing proportion of our cultivated fruits and berries, in addition to a great variety of our most beautiful flowers. The apple, peach, plum, cherry, quince, pear, loquat, and apricot, among orchard fruits, and the blackberry, raspberry, dewberry, salmonberry, cloudberry, and strawberry, among small fruits, are all representatives of the same tribe.

Any plant that has membership in the family must be regarded as having good possibilities of development.

It was perhaps largely a matter of chance that the fruits we have mentioned came under man's

attention at an early date and thus were developed to their present status.

Some other members of the family, such as the hawthorn, the mountain ash, the wineberry, the Juneberry, the thimbleberry, and the bridal rose, have failed to be taken under man's protection and hence have not had their fruiting possibilities developed. But some at least of these are well worthy of consideration, and from among them there will doubtless be developed sooner or later many new varieties of fruit that will be considered valuable acquisitions.

We shall now have our attention called to yet another coterie of fruit bearers of which good things may be expected. Some of these are familiar natives or plants that have become acclimated in this country, others are foreigners known only to the specialist. The fact that at least one or two of them are known as bearers of interesting or beautiful flowers and have been cultivated for ornamental purposes adds interest, and makes the outlook for the development of their neglected fruiting possibilities seem still more enticing.

It should perhaps be added that a few of the fruits to be referred to here are not absolutely inedible even in their present state. But no one of them is to be compared with our standard

orchard and garden fruits. At most they show promise of development.

Almost any one of the potential fruit bearers about to be named offers inviting opportunities for the fruit developer. And some of them are so readily accessible and so responsive to efforts made in their behalf as to make particular appeal to the amateur.

Improving the Barberry

Those who have seen the common barberry with its beautiful, hollylike leaves and abundance of blossoms in the early spring, and who have also noted the attractive crimson fruit it bears in the fall, will readily understand why the improvement of this shrub was undertaken with particular reference to making its fruit attractive to the palate as well as to the eye.

This is a member of a rather large company of plants that combine decorative appearance with the capacity to bear valuable fruit. But it is well known that the possibilities of the barberry in the latter regard have never been developed beyond the initial stages.

Beautiful as the fruit is, it is altogether inedible (except when it is utilized for jelly) or was at the time when my experiments with the plant began.

When I say that this work with the barberry was taken up more than twenty-five years ago, and that I have not as yet produced a variety that seemed worthy of introduction as a fruit producer, it will be understood that this plant is not among those that are specially responsive to the efforts of the plant developer.

It should be explained, however, that the work with the barberries, although it has involved the growing of thousands of seedlings of various species, has been carried out mostly along the lines of selection, without the aid of hybridizing. It is almost certain that crossing the different species would have resulted in carrying the work forward far more rapidly. But the pressure of other work has kept me from undertaking this, and I have been content to select the best specimens of the various species, generation after generation, up to the present time, and thus to advance somewhat slowly, although on the whole rather surely, preparatory to getting improved varieties of each species for crossing.

The most promising of the barberries from the standpoint of the fruit grower is probably the common species familiar in many regions as a hedge plant and known botanically as *Berberis vulgaris*. The genus has many other species, however, and the fact that these tend to vary

indicates to the plant breeder that they have inherent possibilities of improvement. In the course of this work I have imported other species of barberries from South America, British Columbia, Asia, Europe, and northern Africa.

Some of these have proved of value, but the most important advance has been made by the progeny of the common barberry.

During the course of the twenty-five years of experience with this plant, I have been able by persistent selection to facilitate the development of a fruit much larger than that of the parent form, far better flavored, and with a greatly reduced proportion of seed. The fruit has not changed very markedly in appearance, but is produced much more abundantly.

It has all along been noticed that when seeds are planted there is a marked tendency on the part of most of the progeny to revert toward the wild state rather than to go forward, according to man's interpretation of progress. So it is only the exceptional plant that can be saved with any prospect of producing unusually valuable fruit. Nevertheless, as already noted, there has been marked progress and it is always to be remembered that such progress tends to be cumulative and that there may come a time when the plant may vary suddenly and give opportunity for

much more rapid development, a critical point having been reached by previous generations of culture.

It is probable that the final development through which the barberry is made to bear a really valuable fruit will come about through hybridizing the familiar species with somewhat different relatives from other lands.

Material for such hybridizations are now in hand, as I have large quantities of seedlings of six or seven different species.

Two of these species came from the Patagonia and Chile regions. One is a plant called *Berberis buxifolia,* and known to the natives as Calafate. Like many of the barberries the plants are quite thorny. The berry is blue-black in color and the natives of Chile use it to make a liquor said not to be unlike gin.

In addition to this foreigner and a Russian species which produces black fruit, and another producing nearly spherical red fruit, there are several native species that may perhaps be advantageously brought into the cross when the hybridizing experiments are undertaken.

These include the two western barberries (*Berberis repens* and *Berberis nervosa*) sometimes classified as a subgenus called *Mahonia,* and colloquially sometimes called Oregon grapes,

because of the clusters of bluish-black fruit. These are both handsome dwarf evergreen shrubs abundant from British America to central California, also in Colorado. There is also a purple-leaved variety, otherwise not unlike the common barberry, and there are varieties with variegated white or yellow leaves and varieties bearing white, yellow, and black fruit, in striking contrast to the red fruit of the common species. Moreover there are varieties with seedless fruits.

All in all, then, there is opportunity for such blending of racial characteristics as should give the hybrid barberries an impetus to variation, and afford opportunity for rapid development.

My experiments in selection may be regarded as constituting pioneer work, and as affording material for the hybridizing experiments through which the plant may be perfected as a fruit bearer. Already the fruit has been made larger and of better flavor, and the seeds have been minimized. With the aid of crosses of the species named, and also, probably, with the introduction of the racial strains of a wild species of western Texas, Utah, and Mexico (*Berberis Fremonti*), which I now have under culture, and which sometimes bears fruit of exceptional size and superior quality, though not as abundantly as most other species, it should be possible to produce a new

THE ELÆAGNUS OR GOUMI BERRY

The original Goumi berry, as imported by myself some thirty-five years ago from Japan, was a very astringent fruit, and with a very thorny stem. Through selective breeding we have had good success in eliminating the thorns and in improving the fruit. This is one of my thornless varieties. (*About one-third life size.*)

race of barberries that will be a valuable addition to the rather meager list of small fruits.

Improving the Elæagnus

During the early years of my work in California I kept in close touch with all the importations made from Japan by the H. H. Berger Co., of San Francisco, and others. From them I received, among other plants, a curious fruit-bearing plant from Japan, known in its native country as the Goumi berry, and classified by botanists as *Elæagnus longipes*.

No other importation of a member of this genus had hitherto been made, so I viewed the plant with particular interest, and was especially struck with the seeming possibilities of improving its fruit.

The *Elæagnus longipes* bears flowers of a bright, brownish-yellow color, subject to a good deal of variation. The fruit is a berry of varying shades of crimson, rarely changing to yellow. The flavor of the fruit is far from inviting. After one has tasted five or six of the berries, one is scarcely able to describe the flavor or to decide whether others have any desirable quality.

The astringency of the fruit is so great as nearly to obliterate one's sense of taste after two or three have been tested.

Perhaps it should be noted that the tasting of fruit for the purpose of testing its quality becomes a rather unwelcome task for the fruit developer even when the fruits under consideration are plums or peaches or other orchard fruits of the finest quality.

People have often assured me that they would consider it a very great privilege to test different fruits by the hour.

But such an offer only showed their inexperience. No one cares for fruit after he has tested a certain number and the necessity of tasting one kind after another becomes for the fruit developer who operates on a large scale a highly distasteful task. If this is true when fruits of fine quality are in question, it must obviously be doubly true of undeveloped fruits like the Goumi berry, the testing of which gives nothing but discomfort from the outset.

But it is equally obvious that no progress can be made unless the fruits are constantly tested in order to select the best for the continuance of the experiment. And as there is no known substitute for the human palate in making such selection, the tasting of fruits is an unavoidable part of the plant developer's everyday work.

In the case of the Goumi berry, my efforts at selective breeding have been rewarded by the

notable progress of the plant, first in the elimination of the thorns, and secondly, in the improvement of the fruit.

Here and there I have found a seedling, the fruit of which is pleasant to the taste, and by selection through successive generations a variety of *Elæagnus* has been produced that gives great promise.

My experience with the genus has included tests of five species, bearing the specific names of *Elæagnus angustifolia, E. umbellata, E. pungens,* and *E. argentea,* in addition to the original *E. longipes.* There are three closely related plants also belonging to the Oleaster natives of North America, these being *E. canadensis* (sometimes called *Shepherdia canadensis*), *Lepargyrea argentea,* the buffalo berry (called *Shepherdia argentea*), and *E. argentea,* the silverberry of the far Northwest; all somewhat similar plants in general appearance, but quite different from the Elæagnus of the Eastern Hemisphere. The seeds should be treated like those of the pear—removed from the fruit when fresh, thoroughly washed, and kept fairly moist until planting time.

The seedlings grow rather slowly at first, but offer no particular difficulties. I have tried to cross the different species, but thus far without

success, chiefly because the plants bloom at widely different seasons.

Up to the present, therefore, the improvement has all been due to selection and to crossing within the species. After many years of selection my stock of *E. longipes* has finally been reduced to a single plant, a large bush bearing most abundantly each season. The fruits are large and of very good quality. Indeed, the improvement has been so marked that it is not unlikely that this variety, when it has been more fully tested, will be introduced. It has certain attractive qualities that seem to make it worthy of a place in the fruit garden.

The best varieties of the American *Elæagnus,* especially the buffalo berry and the silverberry, are well worthy of cultivation, and extremely promising for work, being enormous bearers of pleasant-flavored, currantlike fruit, which in the wild state is often collected for making jellies, and is far better in quality than the Goumi berry of Japan, although very much smaller.

The best of all these species bear fruit in astounding quantities. The crossing of the best varieties of the American and the Asiatic *Elæagnus* gives as good promise of important results as any fruits that I can mention.